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THE files of the JOURNAL now in its office are complete from the first establishment of the AMERICAN RAILROAD JOURNAL in 1832 up to the present date, with the exception of the numbers from January 1, 1881, to September 10, 1881, and for May, 1885. If any of our old subscribers have in their possession copies of those numbers, or of any of them, and are willing to part with them, they will confer a favor on the JOURNAL by sending notice thereof to its office. In such case the new JOURNAL will be exchanged for the old, by crediting the subscriber for a time corresponding to the back numbers sent in.

FURTHER unfavorable reports continue to come from the Panama Canal. The latest examination made by a competent engineer confirms the statements heretofore made, to the effect that less than one-quarter of the work is done, and that the part which remains to be completed includes the most difficult and expensive sections of the canal. There is no possibility that the canal can be opened at the date set by M. de Lesseps, and there is no probability that it will be completed at all unless there is a change in the plans and methods of the company.

The financial as well as the engineering department of the company seems to be in a bad way. There is much talk of a new loan, but it seems hardly probable that such a loan could be taken except at a discount even more ruinous than the last. How much longer the company can carry its financial burden seems to depend chiefly upon whether it can obtain some guarantee from the French Government.

Meanwhile the Nicaragua Canal people promise to push their surveys, and claim that they are ready to begin work as soon as the plans are completed. Their canal is a sufficiently formidable undertaking, but has certainly better prospects from an engineering point of view. The obstacles are less formidable than at Panama, and the work is all of such a nature that the cost can be fairly estimated; and the chief difficulty will be to provide the money.

THE new President of the French Republic, M. Sadi-Carnot, is a civil engineer by profession, and has served as a subordinate and as Chief of a division in the department of *Ponts et Chausées*. He is one of the few civil engineers who have ever risen to high political office. Why the list is so short, it is, perhaps, not difficult to say. A good civil engineer ought to be a good public officer; he must have some executive ability, and must be accustomed to the conduct of affairs on a large scale. The civil engineer, however, is rarely an orator, or even a good talker; he is more a man of action than of words, and, moreover, has usually little time to devote to politics. He is out of the line of promotion, in which a lawyer, for instance, is usually found. Perhaps it would be better for the world at large if the engineer rather than the lawyer were chosen oftener than is now the case.

THE recommendation of the Secretary of War that guns of modern pattern be supplied to all posts where artillery is stationed, for purposes of practice, seems an eminently sensible one. A good artilleryman cannot be made out of raw material in a short time, like an infantry soldier; he is the skilled laborer, the mechanic of the service, and must have time to learn his business. And if he is ever to be called on to do actual service, it is only reasonable to give him a chance to learn to know and use his tools beforehand. Big guns will be of very little use, if they are ever really needed, unless there are men familiar with their use.

THE new cruiser *Atlanta*, according to the report of her commander, Captain Bunce, is faulty in many respects, and will need a general reconstruction before she becomes an efficient part of the Navy. Some of the changes are slight and could easily be made, probably with advantage. Most of the criticisms, however, are directed not so much against the *Atlanta* alone as against the general type of cruiser which she represents; and if all these are to be met the building of a new ship will be practically what will be required.

With regard to Captain Bunce's recommendations, there was, as might have been expected, much difference of opinion at the Navy Department. The Secretary, however, has taken what appears to be the most sensible course, and has ordered that no changes be made until after extended trials at sea.

THE latest development of the demand for increased facilities for passenger transit in New York City is a plan for a tunnel or underground road from the Grand Central Depot in Forty-second Street to the Battery, which, with the existing line from the Grand Central north, would make a new line from the Battery to Harlem. It is, after all, only a revival of an old project, with some changes in the route. Some of the city papers assert positively that the necessary capital has been secured; but there is some doubt about this, and the company has not yet been fully organized.

A part of the plan is a branch from the City Hall to the Hudson River, to be extended under the river to a connection with the Pennsylvania Railroad in Jersey City. The whole project is an extensive one, but some doubt still remains as to its prospects.

THE elevation of the Pennsylvania Railroad passenger tracks through Jersey City was recently apparently secured,

the authorities of the city having given their consent after a long delay, caused by the opposition of some local interests. The change is one that would be beneficial both to the railroad and to the city at large, while the amount of property which would be injured by it is comparatively small. The new elevated line was to be about a mile in length, and an iron structure somewhat similar to the elevated railroads in New York, but, of course, much stronger, as it was intended to carry the heaviest trains at high speed. Its construction would do away with a number of street crossings, including several at which there is a large traffic, while at all of them there is constant delay and danger from the frequent passing of trains. The advantages gained by the railroad were to be in the ability to handle trains more quickly, as it would not be necessary to reduce their speed, and in the freedom from continually recurring accidents and claims for damages.

The gain to the city in freeing its busiest streets from obstruction, and in greater security against personal injury to its citizens, would appear to be great. Nevertheless, the accomplishment of the work has been delayed for nearly a year by local opposition, and is now possibly defeated. Why this should be so, especially as the entire expense was to be borne by the company, and all that was asked of the city was to vacate a section of one street, is one of those puzzles in municipal government which are very hard for an outsider to make out.

The proposed improvement is entirely blocked for the present by legal proceedings. The company, it is stated, has resolved to take no further action toward securing consent to the building of the elevated line, but it feels the necessity of a change, and will consider the question of removing its passenger station to the present freight-docks at Harsimus Cove.

THE people of Philadelphia, or that portion of them more directly interested, have begun a movement to compel the Philadelphia & Reading Railroad to elevate the tracks leading to its stations in that city. It is proposed at the same time that the two city stations of the company, on Callowhill Street and at Ninth and Green, shall be consolidated into one. The numerous street grade crossings now existing have become a dangerous nuisance, and the presence of the surface tracks in a crowded section of the city is a serious drawback to its improvement. An elevated line, similar to that by which the Pennsylvania Railroad reaches the Broad Street Station, is proposed.

That the change would be a great advantage to the city cannot be denied. The company has not been for a long time, and, indeed, is not now, in a position to pay for an improvement so expensive as this would be. It is not probable that the city would be willing to pay for it, and there will be much friction and discussion before the matter is finally settled. That an elevated line into the city will be the final result there is little doubt.

IT is not many years since the City of New York paid a large sum to secure the separation of the grades of the city streets and the Harlem (New York Central) tracks from Forty-second Street to the Harlem River, and now the residents of the city north of the river are calling for an extension of the work for their benefit. The rapid growth of the city northward has brought a dense population into the annexed district north of the Harlem, and the many grade crossings there are found to be both inconvenient and dangerous. The work would be an expensive one, and it is not probable that the company will undertake it willingly. Some pressure will be necessary, and there is no doubt that the city will be asked to pay part of the expense, as it was in the previous case. The matter has hardly reached a definite form yet, and may not for some time to come.

ALL these cases are different forms of a very difficult problem. In nearly all our large cities the railroad lines were built when the cities were comparatively small. The tracks passed over ground hardly yet occupied, and no one foresaw at the time the future extension of the cities or the great increase of the railroad traffic. The result has been that while the railroads and the cities have been necessary to each others' growth, they have also interfered with each other, and this mutual interference has gone on until it became unbearable. By that time the question of what was to be done has generally become a very difficult one to answer, from an engineering point of view as well as from a financial one. In New York, as in Philadelphia, Boston, Chicago, St. Louis, and other cities something has been done to solve the problems presented, but much still remains to be done. The danger in all such cases is the adoption of some temporary plan which may serve for a time, but will often be found to be in the end the worst and most costly way.

In this case a study of the plans adopted in London, Paris, Berlin, and other great cities abroad might be made with interest and profit to our engineers.

THE proposed lease of the Boston & Providence Railroad to the Old Colony Railroad Company is in the line of that consolidation which has for some years past been going on in New England. The period of consolidation came later there than in other sections of the country ; the companies were older and stronger, and were also kept more closely under legislative control than in other sections of the country, and consolidation has accordingly been more difficult. The question of large or small corporations has been sharply argued and fought over in nearly all the New England States, not only in the legislatures, but also by the railroad stockholders, who have a larger interest and own a greater proportion of the roads there than in other sections where railroads have been built largely on bonds, and have much heavier debts to carry.

Whatever opinion may be held from a political point of view, the engineer and manager sees many advantages on the side of the large companies. In this particular case the Boston & Providence road fits very well into the Old Colony system, and the advantages to be secured are such as probably to justify the payment of the high price asked for the leased line—10 per cent. on the stock and a cash bonus equivalent to over 25 per cent. on its par value.

The Boston & Providence Company is not only one of the oldest railroad corporations in the country, but it has also a very remarkable record. It was chartered in 1831, and the road was opened in 1835, or 52 years ago. It has paid dividends nearly every year since, and the total return to the stockholders for the 52 years reaches an average of about 7½ per cent. a year. Nearly all the net earnings have gone to the stockholders, for the debt has always been small, and is even now only about one-fourth of the stock, although there is included in it the cost of the

Bussey Bridge accident, which has been well up toward half a million of dollars. It is remarkable also in being one of the few railroads in this country whose passenger earnings largely exceed those from freight, a condition to be expected, however, in a line connecting two large cities, both on navigable water.

A GEORGIA newspaper, speaking of the prospects of a local car-coupler inventor, says:

> There are 11,000,000 freight cars in the United States. At $1 per car per year, for the use of the patent, the proprietors would realize the magnificent sum of $11,000,000 per annum; and as the patent is good for 17 years, one can easily see what a fortune there is in this invention.

To say nothing of the probability—or improbability—of one coupler securing a place on all the cars in the country, our Georgia contemporary's estimate is a little out of the way. The last number of *Poor's Manual* gives the total number of freight-cars in the United States at about 846,000. Even allowing for omissions in the *Manual* and for new cars built this year, there must still be considerably less than a round million. The prospective income is thus at once divided by 11; and it is to be feared that the patent will have expired long before even this shrunken figure is reached.

THE trunk lines have agreed to adopt the new plan of charging for car service recommended by the Car Accountants' Association, and with this approval there is little doubt that it will be universally adopted. Under the new plan, as we have already noted, the simple mileage charge is replaced by a charge based about two-thirds on mileage and one-third on time. On the face of the matter this may seem to be complicating matters; but the new charge is very easily computed, and has the great merit that it enables a car to earn something when it is not in motion, and at the same time makes it an object to the company receiving it to return it as soon as possible. Under the old system this motive was entirely lacking.

FEW persons, even among railroad men, who have not made a special study of the subject, realize how great a loss is entailed upon railroad companies by idle freight cars. A car standing in a yard has, heretofore, been earning nothing for its owners, and the proportion of such cars unnecessarily detained when they were needed elsewhere has been so large that it must have involved an appreciable addition to the capital invested in freight rolling stock. How to keep their cars in motion so as to reduce the number needed to the lowest point and to enable them to earn interest on their cost is a problem which has taxed and still continues to tax the ingenuity of many railroad officers. If the introduction of the *per diem* charge will aid them, it will do a good work.

A MEETING was held in Chicago, December 7, for the purpose of securing some uniform method of settling joint freight accounts. There is now great diversity in methods of settlement, and much delay and confusion result. The present meeting had the indorsement of the accountants of many leading roads, and was very largely attended, but failed to take any decided action, although something was done toward securing the desired object, and arrangements were made for another meeting.

This meeting is another illustration of the complex nature of our railroad system, and of the continually recurring necessity of general action to secure uniformity in methods, which is felt in every department of the railroad service. The accountants, like their mechanical brethren, will not be able to reach the desired agreement unless they realize the necessity of making mutual concessions and the folly of insisting too strongly upon individual preferences.

AN AMERICAN RAILROAD UNION.

THE days when a person who was called a civil engineer was considered competent to direct *any* of "the great sources of power in nature for the use and convenience of man" are gone forever. Adam Smith showed the advantages of division of labor in the production of wealth, and pointed out that it was due to three causes:

1. The increase of dexterity in every particular workman. 2. The saving of time which is lost in going from one kind of work to another; and, 3. The invention of labor-saving machines.

Still another reason might be given for the division of labor in engineering—that is, the limited capacity of the human intellect. Engineering at the present time embraces such a wide field that no human being can now have anything like a thorough knowledge of more than a few special branches of the profession—if it is a distinct profession any longer. Fifty years ago an engineer was expected to be able to direct the building of a ship, locate a railroad, design its bridges and machinery, superintend the making of its rails, and, in short, supply the knowledge for doing anything and everything which needed to be done. All this has been changed, and year by year the process of subdivision of industries is carried farther and farther, so that now there are specialists for locating roads; the engineers who build iron bridges do not build wooden ones, and neither design nor construct stone structures. There are firms and companies who manufacture cars for passengers, and do not make any for carrying freight. The locomotive manufacturer does nothing else but build locomotives, and even he has his tires, axles, head-lights, injectors, steam-gauges, oil-cups, and other parts supplied by firms who make a specialty of manufacturing those parts. The same process has gone on in every department of engineering, and will undoubtedly continue.

But while this subdivision is going on, there are influences at work which bring about organization of these divided arts for the accomplishment of definite and common ends. This is shown by the various associations which have been formed of railroad officers and companies, through which they may be able to agree upon such joint action as may be required to promote the objects for which railroads are intended. Similar organizations, which represent other engineering and industrial interests, are increasing rapidly, and undoubtedly will have a very great influence in the future on all branches of engineering, but especially on the operation of railroads. The need of united action and of agreement became obvious very early in their history, and is every year becoming more urgent. When disconnected lines were built in South Carolina, Maryland, Massachusetts, and Ohio, the importance of a uniform gauge did not appear, and then, as now, engineers

seemed to be ambitious to impress their opinions and personality on their work by doing each something different from the other. When the lines were joined the absolute necessity of a uniform gauge became imperative, and at great cost they were made to conform to each other. With the progress and interchange of traffic the need of uniformity in time, in the construction of parts of cars, signals, rules for operating roads, keeping accounts, etc., etc., have made themselves felt, and now every year brings up some question for consideration and action. Various associations have been formed, such as the Master Mechanics', the Car-Builders', the Roadmasters', the Passenger Agents', etc., which take action on matters relating to special departments of railroad operation. These associations act independently of each other to a very great extent, and, quite naturally, the question of their relations to each other has been brought up recently. At the meeting of the General Time Convention, held in October, a resolution was adopted to appoint a committee of five to take up the matter of the relation of all national associations of railroad officials to the Time Convention. Messrs. Charles E. Pugh, Pennsylvania Railroad ; C. W. Bradley, West Shore ; R. H. Soule, New York, Lake Erie & Western ; I. R. Kendrick, Old Colony ; W. W. Peabody, Baltimore & Ohio, were appointed such a committee.

The question is therefore fairly launched for consideration by the Time Convention, and will, no doubt, come up at the next meeting. Some preliminary discussion of the subject will then not be out of place or untimely.

It may be said that thus far no very distinct scheme of organization has been proposed. The Time Convention is a name which does not indicate that the association to which it belongs is composed of railroad companies, and that the representatives of those companies are usually the general managers or general superintendents. The members, therefore, outrank those of the other associations. That fact, then, raises the question whether, if any system of organization or consolidation is adopted, the other associations will occupy a subordinate relation to the Time Convention, or whether they shall have co-ordinate rank and authority somewhat like that of a house of representatives to a senate, or whether the various associations should be consolidated, and then be divided into sections, somewhat like the American Association for the Advancement of Science or the British Association ; the different sections being devoted to the consideration of separate classes of subjects, such as locomotives, cars, road-bed, passenger and freight traffic, accounts, etc.

With any form of organization the question will present itself whether concurrent action of what is now called the Time Convention and the other associations should be required in case any direct relation is established between them. That is, should all measures of importance originating in the various associations be referred to the Time Convention for approval before being finally adopted ? The danger of that would be that it might retard all action to such an extent as to make it impossible or very difficult to do anything.

It should be pointed out that the rules of the Car-Builders' Association require that the adoption of all standards shall be referred to a letter-ballot for decision. This practically brings the most important action of that association before the general managers and general superintendents for revision, because their representatives, it may be supposed, would consult their managers or superintendents before voting. A very simple way of bringing about what has been suggested would be to refer all matters of importance to the Time Convention, to be submitted to letter-ballot by that body. Such measures would be discussed by the Time Convention, and, possibly, referred back to the association in which they originated, with recommendations for amendment. Measures which were first brought up in the Time Convention which relate to cars would naturally be referred to the Car-Builders' Association, or, if they related to locomotives, to the Master Mechanics', and similarly with action relating to other departments. After being discussed and modified, possibly, they would go back to the Time Convention for final submission to letter-ballot.

A very simple amendment to the constitutions of the different associations and the appointment, possibly, of committees of conference, is all that would probably be required to bring about the co-operation that has been outlined. Whether such co-operation would be desirable may be considered an open question. As a preliminary to any action the name of the Time Convention should be changed. The "American Railroad Union" has been proposed instead, and is, perhaps, as good a title as could be suggested.

The constitution of the Time Convention says that "memberships shall be by companies, . . . which may be represented by their President, Vice-President, General Manager, and General Superintendent, or by any official or officials connected with the transportation or traffic department."

The danger is that the officers named will not be able or disposed to give the time to the meetings which will be required to act intelligently on such subjects as would come before them if direct relations were established with the other associations. It would seem to be a better plan to allow the President, General Manager, or General Superintendent to appoint a representative member in the association, as is now the practice in the Master Car-Builders' Association. If they are not able to attend the meeting themselves such officers could select the ablest persons on their staffs to represent their companies.

The whole subject is a very important one, and worthy of full discussion.

THE INTERNATIONAL RAILROAD CONGRESS.

THE International Congress of Railroads, which recently closed a second and very successful meeting at Milan, in Italy, its first session having been held at Brussels in 1885, is an association for which we have no exact parallel in this country. It had its origin, we believe, in a meeting held to arrange a convention or treaty for regulating the exchange of traffic between the railroads of the different European countries, but at the Brussels meeting an organization was completed and the Congress developed into an association for the discussion of questions relating to the construction and operation of railroads. It was then decided to make the association permanent, and to hold meetings every other year, an invitation being issued to all European countries to send delegates. The second meeting was held, as mentioned above, at Milan, in October last, and the third is appointed to be held in Paris, in October, 1889.

The association or Congress has no fixed individual membership, but is composed of delegates named by the railroad authorities of the several countries. As in most European countries the Government either owns all or part of the railroads, or at any rate exercises a strict control over them, in most cases the delegates were sent directly by the Governments of their respective countries. At the Milan meeting all the states of Continental Europe were represented except Russia. There was a delegation from England also, which was strong in its composition in one respect, as it included several railroad men of high standing, but weak in another respect, for few or none of its members were able to take part in the discussions, which were conducted in French, which has been established as the official language of the Congress. Outside of Europe two delegates came from the Argentine Republic and one from Mexico. No railroad men from the United States took part in the conference, although two or three were present as spectators.

The membership of the Congress is not limited to any class of railroad officers, and it is expected that all branches of the service will be represented. The discussions covered a wide range of subjects, and in order that they may be properly dealt with the members are divided into sections, each dealing with a certain class of subjects, as construction, maintenance of way, motive power, rolling stock, management of passenger traffic, etc., etc. Each question, after its discussion by its separate section, is submitted to the full Congress for general debate.

The discussions, however, are not on questions brought up at random. Under the present arrangement the Congress at each meeting selects a list of subjects for the next meeting; under each subject a number of questions are prepared to which the different railroad managements are requested to send answers. A permanent Commission is appointed, whose duty is to publish the proceedings of the Congress and to prepare for the next meeting by collecting and formulating the answers received to the questions, and by preparing or procuring papers or monographs on the designated subjects. This permanent Commission publishes the information thus collected for distribution in advance of the next meeting, so that delegates may come to the sessions fully prepared to discuss the subjects in hand.

In all this, it will be seen, the routine does not greatly differ from that of our own railroad associations, the Commission taking the place of the special committees to which subjects are referred by our Master Mechanics' or Master Car-Builders' Associations. Without disparaging the work done by those and other associations, it must be admitted that the International Congress has the advantage in the more careful previous preparation of subjects, while the publication of reports and papers before the meeting is a practice worth imitating.

In another respect the International Congress resembles our associations. Its decisions are simply recommendations, having the weight which full discussion by experts would naturally give, but no binding force upon the members. As a natural result, we find that those decisions are given with some reservation, the members being, apparently, reluctant to lay down positive rules which they may be afterward required to break in their official capacities and under orders of their superiors, whether the ruling authority be a ministry of public works or a board of directors. This absence of positive authority, however, while it weakens the force of the decisions, does not lessen the advantages derived from discussion and from exchange of ideas and comparison of experiences.

The subjects discussed at the Milan meeting of the Congress and the decisions reached, may be briefly summed up as follows:

In the section of road-bed and track six leading questions were submitted. As to the first, the use of metallic ties, the Congress repeated substantially the decision made at Brussels, that this question must be decided by local circumstances affecting the relative cost of metallic and wooden ties. As to the comparative cost of maintenance, further experience is needed to decide.

On the question of material for bridges, steel of proper quality was recommended, especially for spans of exceptional length. It is pointed out, however, that where steel is used special care in manufacture and testing is necessary.

The fourth question was as to the policy of letting out the maintenance of way by contract. On this point the decision was unfavorable to the contract system.

As to precautions against snow, no general rules were recommended, as local circumstances differ so widely.

For roads of exceptionally heavy traffic the recommendations made amounted simply to this, that the best material should be used and great care taken to keep road-bed and track in good condition.

The section of motive power and rolling stock discussed plans for the best utilization of locomotives, but did not recommend any special plan. For passenger rolling stock the balancing of wheels, the use of better springs, and the greatest possible reduction of weight consistent with strength were recommended.

As to the construction of locomotives, the section held that there was nothing new as to material. The system of concentrating repair work at the principal shops of a road, leaving only light repairs to be made at division shops, was considered the most economical. More care in selection of oils and in keeping axle-boxes properly supplied was urged. The system of premiums for locomotive engineers and firemen was thought to be economical and productive of good results. Further experiments with compound locomotives and with the use of steam or water-jets in place of sand was recommended.

The application of continuous brakes to freight trains was not considered practicable at present, owing to the wide differences in construction of rolling stock in different countries.

The only remaining question before this section related to the lighting and heating of trains. For lighting, gas was highly recommended, but further experiments with electricity were considered desirable. The question of heating was left an open one, and further experiments were called for. Steam heating does not seem to have been considered. Owing to the difference in construction of European cars and the general system of dividing them into small compartments, the heating question there presents some difficulties with which we are not familiar. The car-stove, however, is not yet a burning question there.

The third section, on management, discussed the running of passenger trains, the regulation of passengers—a more important question there than here, where passengers usually regulate themselves—the management of

freight traffic, lines of light traffic, switching and yard service, and the lighting of stations.

The fourth section, on general questions, discussed the employment of women in railroad service; payment of employés; institutions for insuring employés; taxes on railroad property; international relations, and technical publications and statistics.

The fifth section was a special one, devoted to the consideration of questions relating to secondary (branch or feeder) lines. Such lines are now exciting much interest all over Europe, and their construction and organization are regarded as of much importance. The discussions of this section took a wide range, covering construction, rolling stock, management of traffic and stations, and many other points. Most of these were left open for further information, and will be considered at the next meeting.

The very brief summary which space has permitted will show how much ground the proceedings of the Congress cover, and something also of its methods. While the proceedings were characterized by more of the French fondness for routine and formula than would be altogether acceptable here, there were many points which are worth study and, perhaps, imitation, on this side of the water.

NEW PUBLICATIONS.

THE VOSBURG TUNNEL: BY LEO VON ROSENBERG. New York; published (by permission of the Lehigh Valley Railroad Company) by the Author.

Great as have been the changes in all departments of railroad engineering during the past few years, the advance in the art of excavating tunnels has probably been more considerable than in any other branch. Mr. Drinker's work on tunnelling, complete and exhaustive as it was at the time of its publication, already needs supplementing on account of the rapid advances made in the improvement of drilling machinery and the use of new explosives. For these reasons a monograph on tunnelling, like the present one, must always be of interest to all engineers who desire to keep themselves informed in this direction.

The Vosburg tunnel on the Lehigh Valley road is the latest of the great railroad tunnels in this country to reach completion. It is, perhaps, a sign of the advance in the art that the work was undertaken and carried through, not because it was indispensable to the building of the road, but to shorten and improve the alignment of a railroad already several years in operation. At the point where the tunnel was built the original line of the road followed the banks of the North Branch of the Susquehanna around a sharp bend, and the tunnel was built to dispense with the use of a section of road full of sharp curves and difficult to maintain, by substituting a shorter and more direct line leading through, instead of around, the mountain.

The author of this book, Mr. Von Rosenberg, was employed as an assistant in the construction of the tunnel, and had free access to all the drawings and records made by the engineers during the progress of the work. He has made use of his opportunities, as the many illustrations accompanying the work show. These illustrations, with the accompanying text, enable the reader to understand clearly the methods employed in the tunnel, the difficulties encountered, and the varying progress made in different sections of the tunnel.

The book is one of a class which is very useful, but not as large as it ought to be, for nearly all our readers who are engineers know how difficult it often is to find a good description of many of the great works, the records of which are hidden away in the archives of railroad companies, or at the best are to be found only in incomplete form in the transactions of some society.

COMPETING ROUTE MAPS. Chicago and New York; Rand, McNally & Co., publishers.

It has always been a difficult matter for the ordinary traveler and shipper to lay down or to get in his mind accurately the competing routes between the more important points in the country. To pick out the different lines on an ordinary map requires more knowledge of railroad geography than most men who are not specialists in the matter possess; and they are generally reduced to a reliance upon the so-called maps issued by the railroad agents, in which the agent's own road is always represented by a straight line, while the other fellow's runs all around the map and has any number of crooks and turns. The maps in question supply this want by showing the lines as they actually are, each being taken from a correct map of the section of the country between the two points covered. They are small enough in size to be folded and carried in the pocket, and are very clear, the lines being shown in different colors, while the map is not complicated by the introduction of an unnecessary number of small stations. The different roads are shown without fear or favor, and one can see at a glance which line is the most direct and which reaches the more important points by the way.

The maps of this series include the competing lines between such points as New York and Chicago; Chicago and St. Louis; Chicago and St. Paul; Chicago and Omaha; others will be issued until all the important through lines are included. They are of uniform size, and one or more can be arranged in a case as desired.

Nothing in this line more convenient to a large number of people has been issued for some time, and these maps should have a large circulation.

BOOKS RECEIVED.

UNITED STATES GEOLOGICAL SURVEY: GEOLOGY AND MINING INDUSTRY OF LEADVILLE, COLORADO: BY SAMUEL FRANKLIN EMMONS. Washington; Government Printing Office. This is Monograph No. XII of the series issued by the United States Geological Survey, and is a volume of 750 pages, containing an exhaustive account of the subjects of which it treats. It is accompanied by an atlas with maps of Central Colorado, the Leadville District, etc., executed in the admirable style in which all the work of the Geological Survey is done.

REPORT OF THE INTERSTATE COMMERCE COMMISSION: 1887. Washington; Government Printing Office.

IMPORTS AND EXPORTS OF THE UNITED STATES FOR THE YEAR ENDING JUNE 30, 1887: PREPARED UNDER THE DIRECTION OF THE CHIEF OF THE BUREAU OF STATISTICS. Washington; Government Printing Office.

IRON TRADE REVIEW AND WESTERN MACHINIST. Cleveland, Ohio. Messrs. Day & Carter, heretofore publishers of the journal named above, have transferred their entire business to the Cleveland Printing and Publishing

Company, a corporation duly chartered under the laws of Ohio, with an authorized capital stock of $50,000. The officers of the company are: W. M. Day, President; F. N. Carter, Secretary; F. J. Staral, Treasurer; A. Wintemberg, Superintendent. Mr. Day will have editorial supervision of the company's various publications.

THE MARTIN CAR-HEATING SYSTEM. Dunkirk, N. Y.; issued by the Martin Anti-fire Car-Heater Company. This is a very full and carefully illustrated description of the Martin system of steam heating, the smallest details being so described that no one can fail to understand them.

THE TRUE NATURE AND DEFINITION OF INSANITY: BY C. H. HUGHES, M.D., LECTURER ON NEUROLOGY, ST. LOUIS MEDICAL COLLEGE. St. Louis; reprinted from the *Alienist and Neurologist.*

THE OVERHEAD CONDUCTOR ELECTRIC RAILWAY COMPANY. Pittsburgh, Pa.; issued by the Company. This book contains a short article on electric motors for street railroads, followed by an illustrated description of the Finney system of overhead conductors and motors.

THE RAILWAY SERVICE GAZETTE, an excellent paper published at Toledo, O., and devoted to the interests of railroad employés, has bought and consolidated with itself the *Railroad Track Journal*, a monthly paper which has been for some time published, and which was addressed chiefly to section foremen and trackmen.

THE WALDUMER ELECTRIC BRAKE. Cincinnati, O., issued by the Waldumer Electric Brake Company. This pamphlet contains a description of the Waldumer electric brake, and a report made to the Ohio Commissioner of Railroads on some tests of the brake made on the Cincinnati, Washington & Baltimore Railroad in September last.

Contributions.

The Heating of Railroad Cars.

To the Editor of the Railroad and Engineering Journal:

I NOTICE in the December number of the ENGINEERING JOURNAL an article on the Heating of Railroad Cars by H. Q. Hawley. The writer assumes (and I think correctly) that steam from the engine will be generally used, and adds: "The matter most requiring to be tested for the solution of this problem is how to supplement steam from the engine for the time when it cannot be used, before the cars are connected with it, and when it is disabled away from terminal points. . . . Why, then, are the tests now being made confined to the former one, while for the latter use nothing is done, although without providing for it the question cannot be settled?" Further along, after enumerating facts in relation to various means for heating now relied on, and assuming that the methods described for heating when the engine is not available are not practical, he concludes that the problem of car heating is narrowed down to the inquiry, "Can gas be used for it?"

I will state that this company is making tests in that direction. Our cars are being heated by steam from the engine. We have a small upright boiler in each car which receives hot water and live steam from the engine. Under the boiler is a gas-burner, which is lit when the engine is detached from the car. The gas is contained in a tank underneath the car, and is used also for illuminating. We have raised steam in the boiler from cold water in 23 minutes. We are meeting with most gratifying results. The entire apparatus is simple, easily managed, and cheap.

We are using it on our Belleville accommodation train. The cars are detached from the engine at the Relay Depot, East St. Louis, go across the bridge to the Union Depot in St. Louis, and return to the Relay Depot, being detached from the engine from 45 to 70 minutes, often without any reduction of the temperature in the car, and never to an uncomfortable degree. We have had no very cold weather so far this season, but expect by spring to be able to give facts and figures that will demonstrate a practical solution of the Car Heating Problem by proving that steam from the engine and compressed gas under the car will furnish the means for the safest and most economical way of heating passenger cars.

C. H. SHARMAN,
General Superintendent Illinois & St. Louis R.R.

SOME SUGGESTIONS ABOUT BRAKES.

To the Editor of the Railroad and Engineering Journal:

I HAVE read with deep interest the accounts of the triumphal progress of the new Westinghouse brake, and have high admiration for the qualities of mind which enabled a man to overcome so promptly and successfully grave mechanical difficulties in the way in which it was done by the inventor of that brake; but the sentiment which I have seen expressed in the words "the automatic air-brake has been made perfect," is not, to my mind, fully justified.

Mechanical contrivances, at their best, like men and some other things at theirs, are a good way behind perfection.

As nearly as I can judge, counting the cars to weigh 24,000 lbs. each, and the locomotives to have been modern eight-wheelers, the train weighed in the vicinity of 775 tons. This immense weight was stopped from a speed of 40 miles per hour, on level track, in about 580 ft.—truly a wonderful performance in the light of what has been common practice.

In considering this and the other results, however, it should, of course, be borne in mind that they indicate what may be attained under similar conditions, the most important condition being, perhaps, that the train shall consist of empty cars. Now, this is a condition not always easy to be filled. Moreover, it is sometimes less important to protect the cars than to protect their contents. Moreover, a train of empty cars cannot cause as much destruction to a train which it may meet too suddenly as a train of loaded cars might cause.

Suppose, for instance, that the train of 50 cars above referred to had contained the full loads which they were built to carry—that is, 60,000 lbs. each—then the train would have been 1,500 tons heavier, or approximately three times as heavy, and according to a simple rule of arithmetic, it would have required nearly three times as great a distance in which to stop the train, or, in the special case above referred to, nearly one third of a mile, instead of 580 ft. When the loaded train had moved 580 ft. after the instant application of the brakes, it would still

have a speed of about 32 miles per hour, and would possess more than twice as much destructive force as the empty train would when running at speed without any application of brakes.

The experiments have shown in what distance trains can be and ought to be stopped in cases of emergency, but from the fact that brake pressure is adjusted to the empty car, and is independent of the load, the published results are liable to convey an incorrect impression.

Each pound of load should have its percentage of braking effect as well as each pound of car. This seems to be easy to accomplish, and will probably be the next important improvement in power-brakes for freight trains. I say freight trains, because there is not the same necessity in the case of passenger trains, where the load is so small a fraction of the total weight. This matter has not, therefore, until the present agitation in relation to power freight-brakes, been fairly before the railroad world; but how can it fail to be considered now, when the important matter of the adoption of a standard freight-brake is, or seems to be, so near at hand, and when heavier loads are demanded and lighter cars may well be desired?

Before indicating a simple, and what appears to be a practicable, method of arranging the brakes to act on the load as well as on the cars, I would like to call attention to another seemingly desirable feature in brakes.

It is, of course, possible to apply the automatic air-brake with full effect only when the pressure in the main and auxiliary reservoirs is fully up to working pressure. In a train of 50 cars the cubic contents of these reservoirs amounts to about 21 times the contents of the main reservoir.

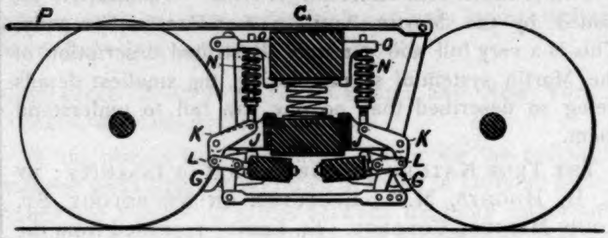
It is very possible for a train to start out from a station without having this large quantity of air up to pressure ready for an emergency. Accidents have often occurred with passenger trains on this account. Freight trains, which must carry so much greater volume of air, will be more liable to them.

Would it not, then, be a great advantage if the brakes were so contrived that it would be impossible for a train to start until the air-pressure is fully great enough for the emergency? In other words, would not a brake be more perfectly and safely automatic which—other things being equal—would hold the train at rest until full brake-pressure was provided for an emergency stop?

The principle may as well be extended to hand-brakes. Would it not be safer for the brakeman, as well as for the train or car, if the labor involved in applying the brake could be done while the car is at rest, and the power thus stored merely released when required?

I am aware that the application of springs to brakes, which shall hold them on until they are wound off by hand or otherwise, is an ancient idea, but elements of impracticability have appeared in methods heretofore brought out or tried. The principle, however, appeals to the reason, and there really seems to be no great obstacle in the way of applying it successfully to practice.

The figure herewith is a section of a freight-car truck, in which the unusual or added parts are: *J J*, brackets attached to the spring-planks, and carrying bent levers *K K*; *L L*, links connecting levers to brake beams; *N N*, compression springs, abutting against brackets *O O* attached to the truck-bolster. These springs are arranged, as will be seen, to force the brake-shoes *G G* against their wheels, and are adjustable. It will also be seen that pulling on the brake-rod *P* draws the brake off, against the action of the springs, instead of applying it. The levers *K* are bent to such angles, and the springs *N* made to such specifications, that the pressure of brake-shoes against wheels will be practically constant within the limits of wear of the brake-shoes. There are two or more



springs to each brake-beam. The apparent advantages of such a construction as this are manifold.

First. The springs may be so adjusted that the pressure of brakes on wheels is exactly that pressure which will give the best effect without a possibility of sliding the wheels on ordinary track. The importance of this matter is well understood.

Second. The bolster *C* is depressed and the springs *N* therefore compressed by an increase of load. The pressure of brakes is therefore greater the greater the load. The importance of this feature is hereinbefore discussed.

Third. No triple-valve or auxiliary reservoir is required —only the air-cylinder to hold the brakes off.

Escape of air, through parting of the train or otherwise, will set the brakes on the whole train, and cars with this brake may run in trains with the present automatic air-brake. Moreover, failure of any brake connection will set the brakes on that car.

Fourth. The brakes cannot be released, and therefore the train cannot be started, until the air-pressure throughout the train is up to full working pressure. Gradual applications may be made quite the same as heretofore.

Fifth. The hand-brake, being used to draw brakes off, may be constructed with such leverage that the work may be done with freedom and ease, and since the power will be generally stored while the train or car is at rest, there will be less danger to brakemen.

Sixth. The method of action of this brake is shown on its surface. It has no complicated feature hard to be understood by men who lack mechanical training.

Seventh. The instant of time required to operate a triple-valve or other intermediate mechanism is saved, therefore the application of brakes throughout a long train may be more nearly simultaneous than with other brakes. Perhaps this feature should have been referred to first, not last.

This statement of advantages is, of course, in the nature of speculative philosophy until the matter shall be put to the test, and thereafter will be in the stage of experimental mechanics until it shall be found to be practically successful; but, curiously enough, up to the last few weeks freight train-brakes, as a whole, have been in the experimental stage; in fact, is any system out of it yet?

The beginning of all advance is thought, or theoretical consideration, as some are pleased to express it. I submit that the theories here set forth seem to rest on good premises. A. K. MANSFIELD.

280 Broadway, New York.

THE PRINCIPLES OF RAILROAD LOCATION.

BY PROFESSOR C. D. JAMESON.

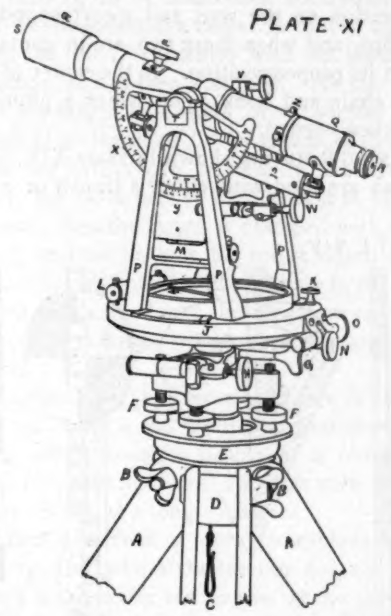
(*Continued from page* 551, *Vol. LXI.*)

CHAPTER V.

OTHER INSTRUMENTS USED IN LOCATION.

THE ENGINEER'S TRANSIT, as built by the different makers, varies to some extent in the details, but the general principles are the same in all, and the type shown in Plate XI may be taken as a typical instrument.

In this plate *A A* are the legs of the tripod; *B B* the thumb-screws by means of which the legs are made fast to the lugs *D* on the tripod-head *E*; *C* is a hook suspended from the center of the instrument, and upon which the plumb-bob is hung. *F F* are the levelling screws, four in



number, by means of which the upper part of the instrument is brought to a level. (On some instruments there are only three levelling screws.)

G is the clamping-screw by means of which the lower plate of the instrument is clamped. *H* is the tangent-screw by means of which a slight but steady revolving motion is given to the instrument after it has been clamped by *G*. At *J* there are two horizontal plates circular in shape and turning on the same center, but separately.

The upper plate of these two has on it two vernier scales at opposite sides of the plate. The lower or bottom plate is divided off into degrees and half degrees. By means of these divisions and the verniers on the upper or top plate, an angle can be read to minutes on the ordinary transit, and on some extra ones to 20 seconds.

K is the screw which works the lever by means of which the magnetic needle of the compass is raised or lowered on its pivot. *L* is one of the two spirit-levels (the other one, *M*, being at right angles to it) by means of which it is known when the instrument is level.

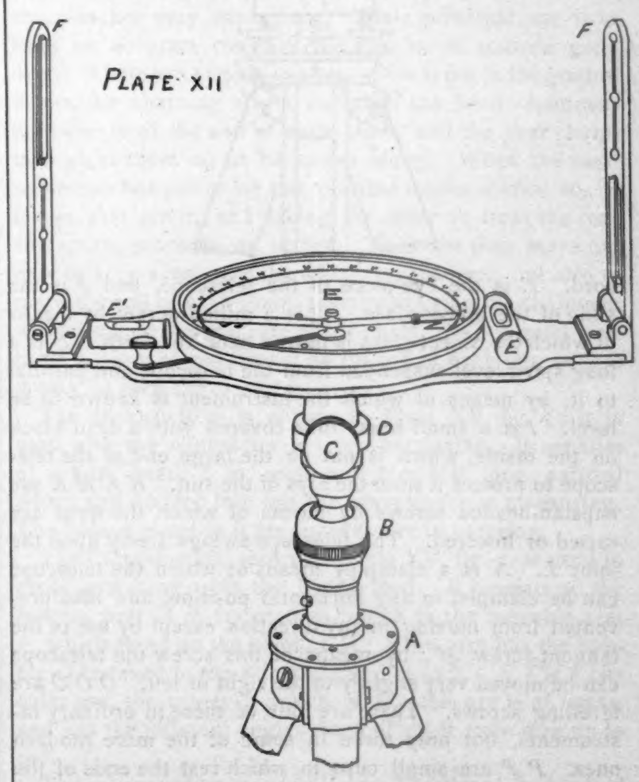
N is the screw for clamping the two plates together, and *O* is the tangent-screw by which the upper plate can be moved slightly but steadily.

P P are the uprights or standards which hold the telescope.

Q Q is the telescope which is held in the uprights at *T*, and can be revolved at will around *T* as a center. *R* is the eye-piece and *S* the object-end of the telescope; *U* is a milled-headed screw by means of which the object-glass is moved back and forth until the object to be looked at can be seen with perfect clearness, or, in other words, is focussed. *V* is the screw for clamping the telescope, and *W* is the tangent-screw for moving the telescope slightly but steadily after it is clamped. *X* is part of the arc of a circle, divided into degrees and half degrees, and is used for measuring vertical angles. *Y* is the vernier scale with which to read the arc *X*. *Z Z* are the screw-heads which hold the rings holding the cross-hairs.

In the telescope are two hairs, one vertical and the other horizontal, whose point of intersection is in the line of collimation of the telescope. When stadia work is to be done with the transit there are also the stadia wires in the telescope. These stadia wires are two horizontal wires at equal distances each side of the center; they are put in immediately behind the cross-hairs. *Q* is a long bubble tube fastened to the telescope and parallel to it. By means of this tube levels can be run with the transit. The upper part of the instrument takes off just above the tangent-screw *H*, and then the lower part unscrews from the tripod at *E*.

The SURVEYOR'S COMPASS, Plate XII, differs from the Pocket Compass already described (Chapter IV) only in the two following points: It is larger, usually having a 5-in. compass-box, and it is mounted on a tripod. *A* is the tripod to which the compass-box is connected by the ball-and-socket joint *B*, by means of which it is levelled. The compass-box sets into the top of the tripod at *D*, and



is held in place by the screw *C*. *E* and E^1 are the bubbles which show when the compass-box is level. The sights *F F* shut down over the compass-box, and when the

screw *C* is loosened the box can be lifted off the tripod and put in a case for carrying.

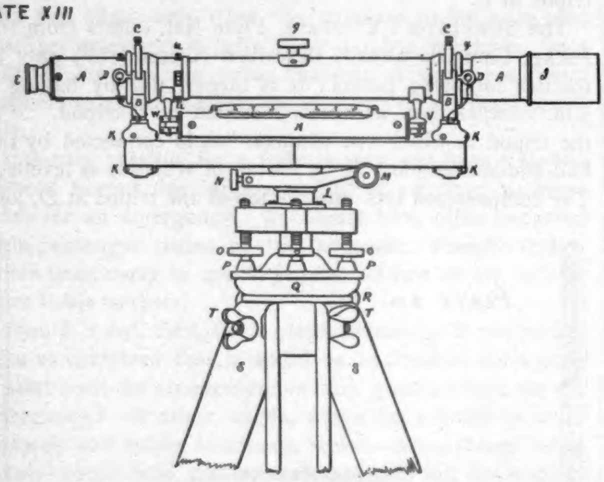
In using the Surveyor's Compass it is set up over any point desired, the position being determined by means of the plumb-bob. The screw *C* having been loosened and the compass-box brought to a level by the hands, the screw *C* is made tight. The instrument is then sighted through *F F* at any desired point, the magnetic needle loosened, and the bearing of the line taken. The direction of the lines being taken by their magnetic bearing, no "back-sights" are used. But apart from this, the method of using the Surveyor's Compass on railroad work is the same as that described for the use of the transit. As will be seen, under certain circumstances the compass is preferable to the transit.

The one thing to guard against is the presence of any metal, such as a knife or bunch of keys, which might disturb the needle by its magnetic attraction.

The Wye Level, as made by different makers, varies in some of its details, but the general principles are the same in all, and all are much like, in details, the one shown in Plate XIII.

In this plate *A A* is the telescope which rests on the two wyes *B B*. The two clamps *C C* shut down over the telescope, and are held in place by the two pins *D D*, which are fastened to the instrument by means of small pieces of

PLATE XIII



cord. *E* is the eye-piece of the telescope, and *F* is the slide of the object-glass. *G* is a milled screw by means of which the object-glass is moved back and forth. *H* is a long spirit-level suspended from the telescope and parallel to it, by means of which the instrument is known to be level. *I* is a small brass tube covered with a dead black on the inside, which is put on the large end of the telescope to protect it from the rays of the sun. *K K K K* are capstan-headed screws by means of which the wyes are raised or lowered. The telescope swings freely upon the joint *L*. *N* is a clamp by means of which the telescope can be clamped in any horizontal position, and thus prevented from moving in any direction except by use of the tangent-screw *M*; by means of this screw the telescope can be moved very slightly to the right or left. *O O O* are levelling screws. There are four of these in ordinary instruments, but only three in some of the more modern ones. *P P* are small cups in which rest the ends of the levelling screws. *Q* is the main plate of the instrument, which screws on to the plate *R*. This plate *R* is fastened to the tripod *S S*, which consists of three wooden legs, painted and shod with metal. *T T* are thumb-screws by means of which any wear in the legs of the tripod where they join the head is taken up, thus preventing all unsteadiness from slack.

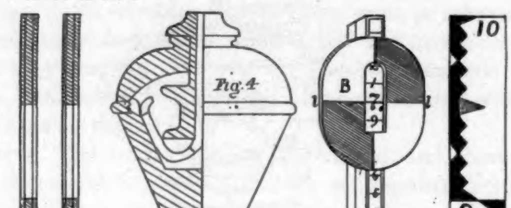
In the telescope of the level are two cross-hairs made of the finest spider web or fine platinum wire. One of these hairs is vertical and the other horizontal. These cross-hairs are fastened to metal rings on the inside of the telescope. The capstan-headed screws *U U* are made fast to this ring, and by means of these screws the hairs can be moved in order to adjust them.

The telescope *A A* turns with ease in the wyes, and as it is necessary to have the bubble *H* always directly below the center line of the telescope, it is a good plan to get the bubble once in its proper place, and then make a scratch running from the telescope upon the wye; then no time will be lost in being sure the telescope is in its proper position, as it only has to be turned until the two ends of the scratch come together.

On some of the more modern instruments there is a little projection on the wye, and a corresponding one on the telescope, and when these two are in contact the telescope is in its proper position. In the center of the tripod-head is a chain and hook, upon which a plumb-bob may be hung when needed.

Two Lining Rods are shown in Plate XIV, fig. 1; they are such as are used with either a transit or a surveyor's

PLATE XIV



compass. They are round or octagonal in shape, and from 6 to 10 ft. long, 1 in. or $1\frac{1}{4}$ in. in diameter at the bottom, and $\frac{1}{2}$ in. or $\frac{3}{4}$ in. in diameter at the top. They are divided into feet, the foot-spaces being painted red and white

alternately. At the bottom the rods are shod with a steel shoe about 1 ft. long. These rods are made of white pine or any light suitable wood. Under some circumstances they are made of small gas-pipe, but if over 6 ft. long these are too heavy for convenience.

The STANDARD LEVEL ROD is shown in Plate XIV, fig. 2. It is divided into feet, and these again into tenths of a foot. For convenience in use the rod is made in two parts, the back part sliding upon the front, as shown. The two parts are clamped together by means of a milled-head screw. The target *B* is quartered red and white, and is made to slide up and down on the rod. When the rod is closed the target is clamped in any position by means of a screw on the back of the rod, which does not show in the drawing. Under ordinary circumstances the target is not used, as the leveller can read to hundredths of a foot through the telescope. But on "Bench-marks" and "Turning Points," or any points where greater accuracy is required, the use of the target is necessary. When the reading to be taken does not require that the rod should be extended the target is moved up or down the rod until the line *l l* coincides with the horizontal hair in the telescope, and is then clamped. At the side of the opening in the target is a small brass vernier scale, the zero of which is on the line *l l*. By means of this scale the elevation of the target can be read to thousandths of a foot. When the level sets so high that it is necessary to extend the rod, then the target is clamped with the line *l l* on the line 7, and the back of the rod is raised or lowered until *l l* coincides with the horizontal hair in the telescope. Then the rod is clamped and the elevation read from the side by means of a brass vernier scale fastened on in the proper place.

Besides the level rod just described there is used a great deal in railroad work a rod similar to that shown in Plate XIV, fig. 3, which consists simply of a rod 10 ft. long, divided into feet and tenths of a foot in such a manner as to be plainly visible at a long distance.

The rod first described is more convenient for the rodman to carry, and where the leveller has not had much experience it is the better rod to use, as the work must go on more slowly, and when the target is used there is less chance for error. With an experienced leveller, however, work can be done with the second rod much faster and with perfect accuracy.

The PLUMB-BOB, as shown in Plate XIV, fig. 4, is the ordinary plumb-bob; it is used with the transit, the surveyor's compass, and sometimes with the level. It consists of a brass weight, the point of which is sometimes of steel. In the top is a hole, through which runs a cord, and the plumb-bob is suspehded by this cord from the hook *C* of the transit (Plate XI). It then hangs precisely on the center line or vertical axis of the instrument, and by means of it the instrument can be set up exactly over any desired point.

The SURVEYOR'S CHAIN is shown in Plate XIV, fig. 5, where part of the chain is represented. Where feet are the standard of measurement, the chain is 100 ft. long. Where meters are used, the chain is usually 20 meters long.

A is the handle of the chain, and the measurements are taken to the outside of this handle. At the point *C* of the handle is a hole through which passes the end *B* of the first link of the chain. This end *B* has a screw thread cut on it and a nut on the inside of the handle, by means of which the chain can be made slightly longer or shorter, in order to correct any error which may be found when the length of the chain is tested.

The long links of the chain are connected by two short links placed between each pair of long links. The object of using the short link is to avoid the liability of the chain catching and kinking. The length of the links is 1 ft. (in a 100-ft. chain) from *A* to *E*.

At each 10 ft. on the chain there is a brass tag. Ten feet from each end the tag has the shape shown at *F*—that is, it has one point. Twenty feet from each end the tag has the shape *G*—that is, two points, and for 30 ft. three points, and so on to the middle of the chain, where the tag is round, like that shown at *H*.

These chains are made either of steel or iron. The steel ones are much lighter, but in a rough country are liable to be broken, as the links will not bend, but snap if caught on a stump or rock, while the iron ones will bend, and can be straightened with a hatchet.

This may be called the first adjustment of the chain. In straightening the links do not strike directly on the link with the hatchet, but put a piece of wood between the hatchet and the link.

The second adjustment of the chain is, after it is perfectly straight, to test its length with a steel ribbon or any other standard of length.

MEASURING PINS, shown in Plate XIV, figs. 6 and 7, are made of steel and are from 12 in. to 18 in. long. Fig. 7 shows one kind, which has a weight, *w*, near its point, the object being to make the pin, when held by the top and dropped, fall vertically.

When stakes are used the pins are not used. But very often a line has to be run and measured where permanent marking on the ground is not necessary, and in this case the pins are very convenient. Their principal use is to keep an accurate count of the number of stations gone over. There are 11 pins in a set. One is put in the ground where the chaining starts, and then the head chainman puts one in at the end of each chain, and the rear chainman picks them up as he comes along. When the head chainman has put in his last pin that marks station 10, he leaves that pin in, and taking the other 10 from the rear chainman, proceeds as before. Thus the pins serve not only to keep account of the distance gone over, but also to mark the end of each chain, thereby showing the chainman where to hold the rear end of the chain. It is a good plan to tie a piece of red flannel on the top of each pin, so that it may be seen the more easily.

The BOARD ROD is shown in Plate XV, fig. 1; it is used with the clinometer in cross-sectioning. It consists of a ⅞-in. board 6 in. wide and 6 or 8 ft. long, painted white, and divided into feet for convenience in measuring. The hole *A* is cut in it for convenience in carrying.

The CLINOMETER, shown in Plate XV, fig. 2, is used in cross-sectioning with the Board Rod. It consists of the bottom part *A B*, fastened to which is the movable arm *C*, which turns on the pivot at *D*. This arm has the bubble *O* fastened to the side and parallel to it. *E T* is a circular arc, the center of which is *D*; this arc is of brass, and has the different angles marked on it from zero up to 90°.

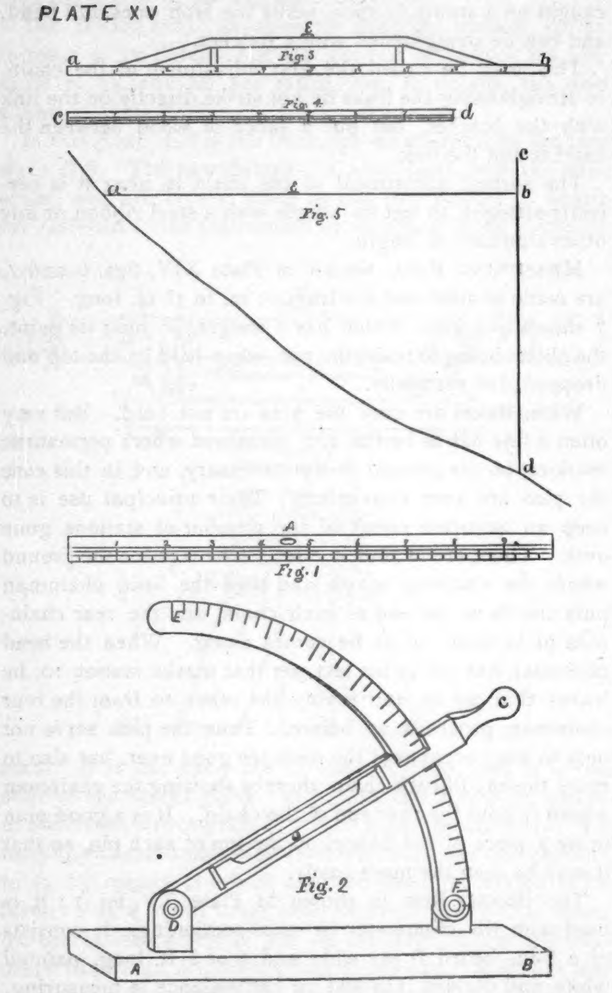
The manner of use is as follows: The Board Rod is laid on the ground on its edge and the Clinometer placed on it. Then the movable arm *C* is raised until the bubble is in the center and the angle is read from the scale *E F*.

This angle shows the inclination of the Board Rod, and consequently the surface of the ground, with the horizontal.

The CROSS SECTION ROD is shown in Plate XV, figs. 3 and 4, in two forms. The first one, *a b*, is a rod 10 ft. long, bound with brass at both ends. It is better made in the shape shown than as a simple rod, as the bracing prevents any warping or twisting. At *e* is a spirit-level set parallel to the rod. In some rods there are two bubbles, one at each end, in the place of the one at the center, *e*. The second rod is simply a square wooden rod about 6 ft. long and divided into feet and tenths. The lower end should be bound with metal. A short level rod is sometimes used in the place of this second rod.

The manner of use is as follows: One end of the first rod is put at the starting point (Plate XV, fig. 5), *a*, and then the rod is brought to a level, one end resting on the

PLATE XV



ground. The second rod is then used to measure the distance from the other end, *b*, of the rod to the ground. Having thus the two measurements, the length of the first rod and the distance, *b d*, measured by the second rod, we have the slope of the surface of the ground.

The STADIA ROD is shown in Plate XIV, fig. 3, which gives a typical form of this rod. It is of wood, 3 or 4 in. wide, and ¾ in. thick. It is divided usually into feet and tenths of a foot in such a manner that the divisions can be very easily seen. Whether it is divided into feet or not depends upon the distance apart of the stadia wires in the telescope, but it should always be so divided that one long division on the rod shall be exactly intercepted by the stadia hairs when the rod is held one chain from the instrument, or, rather, from the focussing point.

CHAPTER VI.

ADJUSTMENTS OF AN ENGINEER'S TRANSIT.

There are five adjustments to an Engineer's Transit (Plate XI), as follows:

1. To adjust the bubble-tubes *L* and *M* parallel to the vernier plate.
2. To adjust the standards *P P* to the same height.
3. To adjust the cross hairs so that one is vertical and the other horizontal.
4. To adjust the vertical hair so that it is in the line of collimation.
5. To adjust the long bubble-tube 2.

1. To adjust the bubble-tubes *L* and *M* parallel to the vernier plate: By means of the levelling screws *F*, bring the bubble of each tube to the center, with the instrument in one position. Then turn the instrument one-half round, and if the bubbles go off the center bring them half-way back by means of the capstan-headed screws on each tube, and correct the other half of the error by means of the levelling screws *F*. Repeat this until the bubbles will stay in the center while the instrument is revolved in any direction.

2. To adjust the standards to the same height: This should be done before the instrument leaves the maker's hands, but this is not always the case. Level the instrument and sight the intersection of the cross-hairs upon some high point, such as the top of a steeple. Then lower the object end of the telescope and find some other point (drive a stake, if necessary) that is cut by the intersection of the cross-hairs. Then unclamp the upper plate and turn the instrument half around. Then sight the intersection again on the high point, and bring it down to the lower point, and if the intersection strikes the lower point, the standards are all right; but if it does not strike the lower point, then, by means of the screws at the top of the standards, correct one-fourth of the error and repeat the trial, moving the lower point each time until the adjustment is perfect.

3. To adjust the cross-hairs so that when the instrument is level one is vertical and the other horizontal: The cross-hairs are fastened upon the metal ring at exactly right angles with each other, so that if one of them is vertical the other will be horizontal. When the first and second adjustments have been made, level the instrument and sight the vertical hair upon a cord held in a vertical position by a plumb-bob, and if the hair coincides with the plumb-line it is in adjustment. When it does not so coincide two opposite screws at *Z* should be loosened and their heads tapped gently with a knife, until the hair does coincide with the plumb-line. The hair is then vertical, and the other hair will be of necessity horizontal.

4. To adjust the vertical hair so that it is in the line of collimation: Set up the instrument and level it, then sight upon a chain-pin set at a point some distance away; reverse the telescope, and put in another pin on the line of sight. Unclamp the instrument at *G*, and revolve it until the cross-hairs again cut the first point; then reverse the telescope again, and if the cross-hair still cuts the second point, then it is in the line of collimation, and the three points taken (the transit and the two pins) are in one straight line. But if on removing the telescope the second

time the cross-hair does not cut the second point, put a pin in where it does cut, measure the distance between this and the second pin, and put another pin in at one-half the distance; then put in another at a point half-way between the second and third pins, loosen the screws at *Z*, and move the ring until the hair cuts this last point. Then tighten the screws and repeat the operation until, upon reversing the instrument twice, the sights all come in the same straight line. After making the fourth adjustment, see that the third one is all right.

5. To adjust the long bubble-tube *Q*: In doing this we first place the telescope exactly horizontal, and then bring the bubble-tube exactly parallel to it. The manner of proceeding is as follows: Drive two stakes into the ground, and with the level bring the tops of these stakes to exactly the same height. Set the transit in a line with these two stakes, level it, and take the reading on the level-rod held on top of each of these stakes. Then by trial move up and down the telescope, and also the target on the level-rod until we have at last reached the point where the reading on the level-rod is the same on both stakes. When this is so, clamp the telescope and test the reading. The telescope is then exactly horizontal. If the bubble in the long bubble-tube is then in the center, this tube is parallel to the telescope. If the bubble-tube does not stand in the center of the tube, then, by means of the capstan-heads, the end of the tube can be raised or lowered as may be required, and by this means the bubble brought to the center. While the telescope is still clamped in this horizontal position it is always a good plan to examine the vernier of the vertical circle and see if it stands at zero. If not, by means of the screws on each side of this, the one being loosened and the other tightened, the vernier can be slipped until the zero of the vernier corresponds with the zero on the vertical circle.

In case there is no level convenient by means of which to bring the tops of the two stakes to an exact level, this can be done by means of the transit, as it makes no difference whether the telescope is horizontal or not. Set the transit up firmly and bring it to a level; then, with the telescope approximately horizontal, measure off a certain distance from the transit, say 300 ft., and drive a stake. Take the reading with the level-rod from the top of this stake through the telescope, then unclamp the two plates of the transit, revolve the upper plate 180°, measure off exactly the same distance from the transit, and drive a stake until the level-rod held on the top of it gives the same reading as on the top of the first stake. Then, although the telescope of the transit is not necessarily horizontal, the tops of these stakes must be absolutely upon the same level, provided proper care has been taken in measuring the equal distances on each side of the transit.

CHAPTER VII.

ADJUSTMENTS OF THE WYE LEVEL.

The adjustments of the Wye Level are all very simple, and only need care and practice. Much care must be taken not to strain any of the screws by using too much force. When for any reason a screw does not turn easily, find out what the reason is and remedy it.

Before making any adjustments, screw the eye-glass well home, and make a scratch on the edge of the frame, so that at any time one can by examining see at once whether the eye-glass is in exactly the same position, because if this is not so it will be no use to adjust the instrument.

There are three adjustments to the level.

1. The adjustment of the cross-hairs. To see that their point of intersection shall strike the same point on a distant body all the time while the telescope is being turned an entire revolution in the wyes. This is called the *line of collimation*.

2. The adjustment of the bubble-tube *H*, to place it parallel to the line of collimation.

3. The adjustment of the wyes by which the telescope and long bubble-tube are supported, so that the bubble-tube and line of collimation shall be at right angles to the vertical axis of the instrument, and remain horizontal while sights are being taken on various points.

1. Adjustment of the cross-hairs: Set up the instrument firmly on the ground. In this adjustment it is not necessary to level the instrument, but it should be approximately level. Pull out the eye-piece *E* until the cross-hairs are plainly visible. Then sight the instrument upon some distant point, or better, upon a vertical line, such as the cord of a plumb-bob. By means of the milled-head screw *G* move the object-glass until the point can be plainly seen or brought to a focus. In focussing an object the object-glass is the only one that must be moved. The eye-glass should only be moved to focus the cross-hairs, and then not touched. Clamp the instrument with *N*, and by means of the tangent-screw *M* set one of the cross-hairs exactly on the point or line. The clips *C C* having been opened, the telescope is then, without any jar, gently revolved one-half. If, then, upon sighting through the telescope, the hair still coincides with the point, that hair is in adjustment, and we proceed to examine the other hair. But if it does not coincide we then, by means of the screws, move the ring which holds the hair in the opposite direction from what ***appears*** to be the right direction, and as near as can be judged by the eye, one-half the distance that the hair is off the point. Turn the telescope back to its first position, and by means of the clamp and tangent-screw set the hair again on the point and again revolve the telescope. If necessary, move the ring again, and so on until the hair is in perfect adjustment. Then proceed with the other hair in the same way, and when both are in perfect adjustment their intersection will strike exactly the same point while the telescope is turned entirely around.

2. Placing the long bubble tube parallel to the line of collimation: In this there are two separate adjustments, one horizontal by means of the screws at the end *W*, and one vertical by means of the two vertical nuts at the end *V*. To make the vertical adjustment, turn the telescope until it is over two of the levelling screws that are diagonal, and clamp it, and open the clips *C C*. Bring the bubble to the center of the tube by the levelling screws. Lift the telescope gently out of the wyes, turn it end for end, and put back in the wyes. Then if the bubble is still on the center, it is in adjustment; but when the bubble is off the center, bring it half-way back by means of the screws at *V*, by either raising or lowering the end. Bring the bubble back the other half of the error by means of the levelling screws, and lift out the telescope and reverse it the same as before. Repeat this operation until the bubble remains exactly in the center when the telescope is reversed in the wyes. To make the horizontal adjustment, bring the telescope over two diagonal levelling screws and clamp it; then bring the bubble to the center by means of the levelling screws, taking care that the bubble is directly

under the telescope. When the bubble is in the center, turn the telescope slowly to one side in the wyes, about ¼ in., and watch the bubble. If it goes off the center it must be brought half-way back by means of the screws at the end *W*, then the telescope turned back so that the bubble comes directly under it, and the bubble brought to the center again. This must be repeated until the bubble stays on the center when the telescope is turned in the wyes and when it is under the telescope.

3. To make the height of the wyes such that the line of collimation is at right angles with the vertical axis of the instrument: Turn the telescope over two diagonal levelling screws, but do not clamp it; bring the bubble to the center, then swing the upper part of the instrument half round, so that it stands end for end over the same two screws. If the bubble is still on the center the wyes are in adjustment, but if the bubble goes off the center it must be brought half back by means of the screws *k k*, and the other half by means of the levelling screws. This must be repeated until the bubble stays on the center when the instrument is swung round.

(TO BE CONTINUED.)

THE MILLER PLATFORM AND COUPLER PATENTS.

(*Continued from page* 452, *Vol. LXI.*)

WE come now to the discussion of the Miller 1866 patent, and the questions involved are very complex. To the mechanic who has thoroughly mastered the Janney system as used upon the Pennsylvania Railroad cars the matter may be clear, but without such a mastery of the subject the following explanation will not be of much avail so far as making the matter clear is concerned.

In the case of the 1866 patent, as in the case of the 1865 patent, two claims were said to be infringed, the *first* and the *third*. The first claim related to the system of trussing the platform, as shown in the Miller patent. This claim, though evidence was taken by both sides in regard to it, was abandoned by the complainant's counsel toward the close of the case. This was done probably because in the course of the testimony it became evident that the Pennsylvania Railroad cars did not have the system of trussing described by Miller, and that what the defendants did have could not be called an equivalent for what Miller claimed.

Miller claimed four trusses; the defendants had two trusses (so called by the complainants) and two horizontal stay-rods. Thus the defendants sustained their platforms by a mechanism substantially different from the mechanism described and claimed by Miller. As in the case of the first claim of the 1865 patent, the first claim of the 1866 patent was abandoned likewise, and therefore it will be needless to go into this subject in detail, for to do so would require extensive diagrams and much explanation.

Turning now to the third claim of the 1866 patent, which was considered by both sides as the most important, we find it reads as follows:

3d. The construction of spring-buffers and couplings, substantially as herein described, to produce compression between cars which are coupled together, so that the spring-buffers and couplings shall constantly act together to prevent shocks and jerks in starting, stopping, or running trains, said buffers and couplings being arranged substantially as set forth.

It was understood by both sides that what this claim meant was as follows: Coupling cars so that their couplers should have pressure on their draw-faces or surfaces to hold the cars together, while the buffer or buffers should be exerting their pressure to force the cars apart. The action of the buffers to separate the cars being resisted by the couplers at their draw-faces, the whole being thus put under the influence of two strains, one given by the buffer-springs to separate the cars, and the other a result of the action of the buffer-springs transmitted to the couplers to keep the cars together.

Now, Miller was not the first person by any means who thought that it would be a good thing to subject the cars to the double strain of buffers and couplers, each operating in its own direction.

This method of coupling cars had for many years, and since the earliest days of railroading, been the common method abroad. Indeed, all cars in England and on the Continent are coupled by devices which put the cars under exactly the same conditions of strain as Miller claims. However, the foreign cars arrive at the desired end by different methods, and just here is the point where Miller devised something said to be new. In the foreign cars the coupling is usually first effected by a link, and then the attendant by means of a screw proceeds to so shorten the link as to put the buffers into compression, which compression placed upon the buffers necessitates a strain upon the drawing or active surfaces of the coupling mechanism. But this result is reached usually in the foreign cars by the manual operation of an attendant, while in the case of Miller the result is reached by using the power of the engine, which compresses the buffer-springs, and by the use of automatic couplers, which, when the buffers are properly compressed, couples the cars automatically.

In this way and by these appliances Miller saves the services of the attendant to screw up the coupling link, and by using the power of the engine and the instantaneous action of an automatic coupler, makes a coupling which, when effected, gives the desired strains to the cars, and does not require manual exertion to effect. However, the condition reached is not a new condition for the cars to be under, for all foreign cars are under precisely the same conditions of strain, only it is usually arrived at in a different way. Therefore, what is left of novelty for Miller to claim is his supposed new way of arriving at the desired condition of strain.

Therefore, the first thing necessary to an understanding of the matter is to ascertain just what Miller showed in his 1866 patent. In this patent a draw-hook having at its rear end a draw-spring projects from each end of each car. Above this hook and in the buffer-beam a buffer is located having at the rear of its shank a buffer-spring. Now, the buffer-face is so arranged that when the car is not coupled to another car, but stands in its normal condition, the buffer-face is out beyond the draw-face of the hook, say 2 in. more or less. This is the normal condition of the parts when the cars are not coupled. Suppose that this car is now to be coupled to another like car, as the engine drives the cars together the buffers first meet and the buffer-springs are compressed, and this continues till the draw-faces of the respective hooks interlock, when the coupling is completed. In this condition the compressed buffer-springs must react against something, and they do react against the springs of the draw-hooks, in this way loosing some of their compression and transferring it to the draw-hook springs, which, in their turn, are com-

pressed to the extent of the expansive power of the buffer-springs. The cars are now forced apart by the buffer-springs, and are held together by the draw-hooks and their springs, both sets of springs being under compression.

This condition of strain is the same as all European cars are subjected to, but in the case of Miller it is obtained by the force of the engine, which, operating in connection with automatic couplers, saves the trouble and expense of a man to screw up the coupling links, for with the Miller system, when the right amount of compression in the buffer-springs has been had, the couplers automatically interlock, and the work of an attendant is avoided or dispensed with.

Let us now see what Miller showed in his patent.

The cut given herewith is a longitudinal vertical section, showing the abutting ends of two cars. *D D* are the hooked draw-bars, *E E* the buffer-faces, *C C* the buffer-beams. It will be noticed that the buffers are shown as slightly compressed or forced inward, their faces being pressed together by the buffer-springs *h*. This pressure finds its way to the draw-bar springs *g g*, which are also slightly compressed, or upon which a compressing force is exerted. *B B* in the cut represents one of the bolster-beams located near the end of each of the cars.

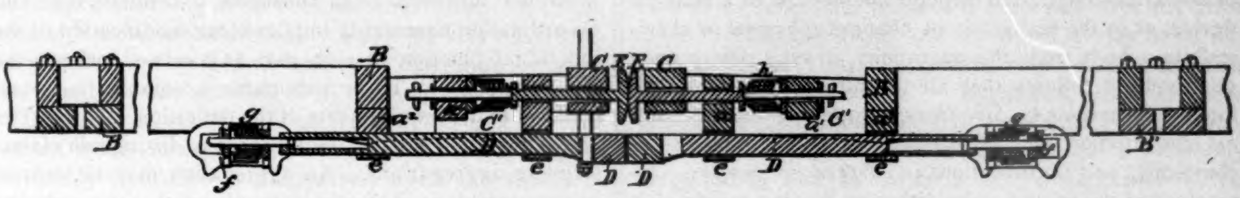
Miller in his patent says as follows :

Another object of my invention is to prevent the sudden and injurious jerks and concussions of cars in stopping or starting a train by the employment of centrally arranged spring couplings and buffers, in such manner that these parts are under constant tension or compression when the cars are coupled together, and the buffer-heads are brought in contact with each other, thus forming a continuous connection of all the cars in a train, as will be hereinafter described.

After this Miller describes the details of his structure, but the above fairly sets forth the spirit of his mechanism. It will be needless to here describe the details of the Janney coupler as used by the Pennsylvania Railroad, as this mechanism has been fully described in a previous article relating to this case.

The first difference between the mechanisms that suggests itself is this : In the Miller mechanism the strain of the buffer-springs when the car is coupled and at rest has to pass through the woodwork of the car before it reaches the coupler-springs. In the Janney mechanism this strain never leaves the coupler and buffer mechanisms, which form a distinct device bolted to the car, but having the strains confined to the mechanism itself, without passing the same through the woodwork of the car.

In the Miller mechanism the buffing is central, and this feature is dwelt upon by Miller as a distinct point of advantage, while in the Janney structure the buffing is done by two side buffers in part, but principally by the draw-heads, which are themselves buffers, and, in fact, do most of the work of buffing. In the Miller structure none of the buffing action can be done by the hooks.



THE MILLER PLATFORM AND COUPLER.

Longitudinal Section.

As a matter of fact, in the cars of the Pennsylvania Railroad, as constructed during the life of the Miller patent, it was not intended that the side buffers should be under compression when the cars were coupled and standing at rest. By reason of the yoke mechanism used with the Janney system, it was intended that the side buffers should only come into play and co-act with the opposing buffers when the coupler-head was moved inward or outward, and clearly this was a condition of affairs never contemplated by Miller, for in his structure when the draw-springs were under the most forcible compression in running his buffer-springs were under the least compression, and *vice versa*.

Miller never contemplated making his couplings other than couplings ; they never were to act as buffers, and could not so act. Now, in the Janney system as used on the Pennsylvania Railroad cars, the coupler-head was the most efficient buffer used, and by the connection of the coupler to the buffers the motion of the former was sent to the latter, but always in such a way as to cause protrusion of the buffers ; thus all the springs were put under compression together or were released together. By the yoke mechanism the strain of buffing in the Janney system as used on the Pennsylvania Railroad cars, whether this strain was taken by the side buffers or by the coupler, was always transmitted to a point below the floor timbers of the car. In the Miller structure, on the other hand, this strain was always sent back in line with the floor timbers of the car, and this feature of the structure is probably essential with Miller.

Pages could be written relating to the mechanical differences of the two structures, but it seems rather useless to follow the subject up in this connection. The reason is this : In the trial of the case all the questions discussed as to the 1866 patent were left undetermined, so far as the court or jury went, and though testimony was taken regarding the patent, the removal of the case by the court from the jury on the grounds previously stated obviated any necessity for a determination of the questions of invention, infringement, or anticipation.

The case was tried by Mr. S. D. Cozzens for the complainant, and he had Mr. E. S. Renwick as an expert. For the defence Mr. Edmund Wetmore, of New York, and Mr. Andrew McCallum (counsel for the Eastern Railroad Association) appeared, and they had Mr. H. L. Brevoort, of New York, as an expert.

Since the above was written it has been said that a suit under the Miller 1865 and 1866 patents is to be pressed against the Pittsburgh, Fort Wayne & Chicago Railroad. This road uses a somewhat different arrangement of coupler and buffers from these described, having, it is true, the Janney system, but without the yoke lever used by the Pennsylvania Railroad. It is said that a somewhat new state of facts will appear in this case.

PATENT CLAIMS.

By Emil Starek.

Experience confirms the fact that the time in which a patent can be secured depends largely upon the ability of the applicant to state clearly and properly the claim covering his invention.

In his attempt to "set forth the precise invention for which a patent is solicited," the applicant is beset with difficulties which only the experienced practitioner can readily surmount; and, although general suggestions as to how to state the claims are found throughout books on patents, and in the decisions of the Commissioner and the courts, the writer has attempted in the present communication to offer a *résumé* of such suggestions, which, it is hoped, may be of service to inventors and patent solicitors.

Inasmuch as the embodiment of any idea is only capable of ocular demonstration through the medium of a material device, or in the realization of changes (physical or chemical) in a body from the operations of such device upon said body, it follows that all inventions can be divided into (1) Inventions in *Structure*, comprising (*a*) mechanical construction and (*b*) composition (either physical or chemical), and (2) Inventions in *Method* or *process*. Inventions of the second class, although dealing purely with abstract elements, require the assistance of material elements for their realization. Under mechanical construction and composition an example is unnecessary. An interpretation of the meaning of process (or method) would, however, be facilitated by an example: In the patent law meaning, a method or process is "an operation performed by rule, to produce a result by means not solely mechanical;" *e.g.*, a claim for "the mixing of crude India-rubber with sulphur, and then subjecting the mixture to a high degree of heat," would be a process claim; and, in accordance with the principle above enunciated, the realization of the process is only manifest through the medium of material elements co-operating to effect the desired result.

I shall now venture to offer such suggestions regarding the drawing up of claims as are the outcome of corrections and recurring amendments to improper claims daily presented to the patent examiner; and that the suggestions herein offered may be fully *en rapport* with the practice of the Patent Office, I shall avail myself of the most recent decisions by the Office, and in the selection of definitions of certain terms set forth therein.

A machine is a contrivance by means of which a force applied at one point is made to produce an effect at some other point. The very definition of a machine carries with it the idea of transmission, and the transformation or modification of the power so applied. To accomplish either, whether the result of the power applied be constant or variable, it is evident that some inter-relations between the different parts of the machine must and do exist; and that the relation which one element of the machine bears to its neighbor is communicated throughout the entire train of mechanism. Let us take, for example, a locomotive engine. It is manifest that if we remove the connecting-rod, or the piston-rod, the engine becomes inoperative. Again, if we vary the cut-off, or the lead, or shift the point of release, we secure variable results in the action of the engine. Before the removal of the connecting-rod or the piston-rod the engine of the locomotive presented an operative device or machine, every element of which so co-operated with every other, and whose inter-relations were such as to be capable of the transmission and variation of the power applied as implied in the definition. Prior to the removal of the parts referred to, the locomotive presented what, in the patent meaning, is termed an "operative or complete combination." Now, an operative combination does not necessarily imply or necessitate *motion* between the elements of the combination, as would be the case of a train of mechanism driven by steam or other motive power. The elements of such a combination may be stationary, but at the same time hold communicative relation with each other; *e.g.*, the flues joining two smoke-drums in a hot-air furnace. A removal of the flues would result in an incomplete combination. To use the language of the Honorable Commissioner, "considered as a generic term a combination may be defined to be a union of mechanical elements involving such a co-ordination of individual functions as to constitute a common function. Co-ordination necessarily implies some modification of the individual function of each part as it existed prior to the combination." "To be patentable a combination must conform to the requirements of the definition. . . ." The above definition will, no doubt, serve to distinguish claims for mere aggregations. An aggregation may be defined as an assemblage of elements so placed that the action or function of one in no wise affects the action or function of any other element in the same assemblage or aggroupment; each performing its function as if the others did not exist; so that the removal of any one of them would leave the remaining ones in precisely the same condition as they were before such removal.

There are, however, two very important intermediate phases between a combination proper and an aggregation, sufficiently well defined to receive consideration in this connection. (1) Two devices may be so constructed as to possess two features (structural) in common. On combining such devices the two structural features may be made to blend into *one*, subserving in that position a duplicate function. When so combined, although the action of the one device in no wise affects that of the other, separation of the one from the other is precluded by the relation of the feature alluded to as blended and now essential simultaneously to both. Although such a combination does not involve co-ordination of function, and is neither an aggregation proper, as the two devices can be separated by simply restoring the common element now blended, it follows that a claim covering such a *pseudomorphic* (if such a word be allowable) combination can only, with propriety, be drawn to the specific construction of the resulting device. (2) This phase refers to a combination of elements so related that, although their combined co-operation produces a result properly termed unitary, an element may be removed from the combination in its entirety without destroying the operation of the remaining elements, but simply altering or reducing their functional capacity.

Inasmuch as the drawing of claims for methods (or processes) and the combination phases above referred to are attended with no serious difficulties, and as such claims are in the minority in the course of patent practice, we shall at once proceed to the consideration of true combination claims. It is essential, and *en rapport* with the practice of the Patent Office, that, as expressed in frequent decisions, a claim should clearly define the combination

intended to be covered by the invention. This is by no means an easy matter.

In cases where a specific combination constitutes only an improvement of the device of which it forms an essential element, applicant frequently introduces said device in the introductory form of a phrase, for purposes (1) to definitely locate such combination, and (2) to introduce inferentially that term in the phrase to which the improvement belongs, as an element of the combination covering the improvement; *e.g.*, "In a car-heater, the combination with," or "in a hot-air furnace, the combination with," etc. Unless the combination cited after the introductory phrase be complete in itself, the claim citing such cannot be regarded as citing a legitimate combination, and should not be allowed. The requirement that a claim shall define the combination intended to be covered by the invention is, in practice, either wrongly interpreted or misunderstood. Now, the true aim in defining a thing is to settle the thing in its compass and extent. A definition of a word in the dictionary would be very unsatisfactory if we were obliged to look up its derivation or origin for a perfect understanding of its meaning; or, in the case of a compound word, look up the definitions of the individual words forming it. A combination claim may be favorably compared to a compound word, and should be so defined as not to necessitate reference to the specification for its disclosure. Furthermore, like a compound word whose definition depends upon the limitations which one of its components puts upon the meaning of the others, so, a claim can only be satisfactorily defined when the relation and the co-operation between the different elements composing it are clearly set forth; and this can only be accomplished by including each element as a positive component and not by simple inference. Again, whatever relation an element may occupy in a working combination, that element is always characterized by the function or functions peculiar to itself; but it is also true that these functions might characterize a vast number of other elements, differing structurally, perhaps, and yet capable of being substituted in the mechanism. So that it is obvious that a combination cannot be well defined by a statement, wholly or in part, of the functions of the elements composing it.

It is frequently the case that an element of a combination is introduced as a link in the chain of mechanism covered by the invention, which link does not constitute an element of the invention, but is essential to its operation. Such a link is usually introduced by the words "means for" or "mechanism for," followed by a participle indicative of its function. Such "means for" or "mechanism for" may be *any* means, and which are not intended to express any patentable difference over the prior state of the art. When such an expression as "means for" or "mechanism for" is introduced and signifies intermediate relation between two contiguous elements, the claim at once becomes complete as a *patentable* combination, and also as a *mechanical* combination. Sometimes, however, the "means" referred to do not hold an intermediate position between the adjacent or contiguous elements of an operative device, but may hold a terminal position with respect to a combination which, of course, must be complete as a patentable combination. In such a case the "means for" may be omitted from the claim altogether; when omitted the remaining combination will be complete in the patentable sense (since the patentability does not depend on the "means for"), and, when added, the combination will be complete both in the *patentable* and *mechanical* sense. It is, of course, obvious that to add the "means for" in such a case would only be a superfluous and unnecessary addition to the language used in describing the combination which establishes its patentability.

When the number of elements of a mechanically complete combination are few, and their relations are such that the "means for" or "mechanism for," not determining its patentability, can be omitted in accordance with the principle just enunciated, it frequently happens that the remaining elements may be so reduced, *numerically*, as to present no longer a "combination," but only a single element, either simple or compound, or, to use a mathematical expression, the number of terms of the combination has reached the *inferior limit*. Such a device, although by itself inoperative, can be claimed *per se* in view of the functional features it possesses over any prior device in the same line, and on which it may be an improvement; or, from its nature, may be claimed as an "article of manufacture." Applicants, however, very often make their claims too fragmentary in their attempts at "inferior limits" in cases where such limits are wholly inapplicable, and so claim a device suggestive of no special function over the prior state of the art; *e.g.*, an applicant may claim, "In a car-heater, the steam-pipe *a* leading from the locomotive through the cars, etc." There is still another error to which applicants are liable, and which is a matter of considerable importance, and that is, claiming the *whole*, with parts of itself, or with intangible elements, such as holes, openings, and the like, which are but structural features, and not mechanical elements susceptible of combination.

Since the conception of a material object is formed from its definition in the mind "by bringing any given object (or impression) into the same class with any number of other objects (or impressions) by means of some characters common to them all," it follows that the object so conceived becomes a generic type for any or all such objects as may possess some characteristic peculiar only to themselves. In the matter of claims, where the combination presented is of such a nature as to admit of illustration by more than one specific construction, it is permissible to have a generic claim, and under the rules one specific claim, to illustrate such genus. A method or process claim cannot be made specific to any generic claim; and this results from the peculiar nature of the elements composing it. A claim for a method recites the successive steps involved in that method, and any addition to, subtraction from, or variation of, such steps would involve a change in the method or process, which process would not be regarded as specific under the former process considered as generic, but would constitute a claim for a different method or process.

The ordinary rules employed in drawing combination claims should be observed (with the necessary modifications and omissions) under method or process claims.

Although the subject of claims is by no means exhausted in the present communication, it is thought that the foundation rules upon which claims are to be built have been laid down; and in their observance much time will, no doubt, be saved by both applicant and examiner, and thus insure speedy issue.

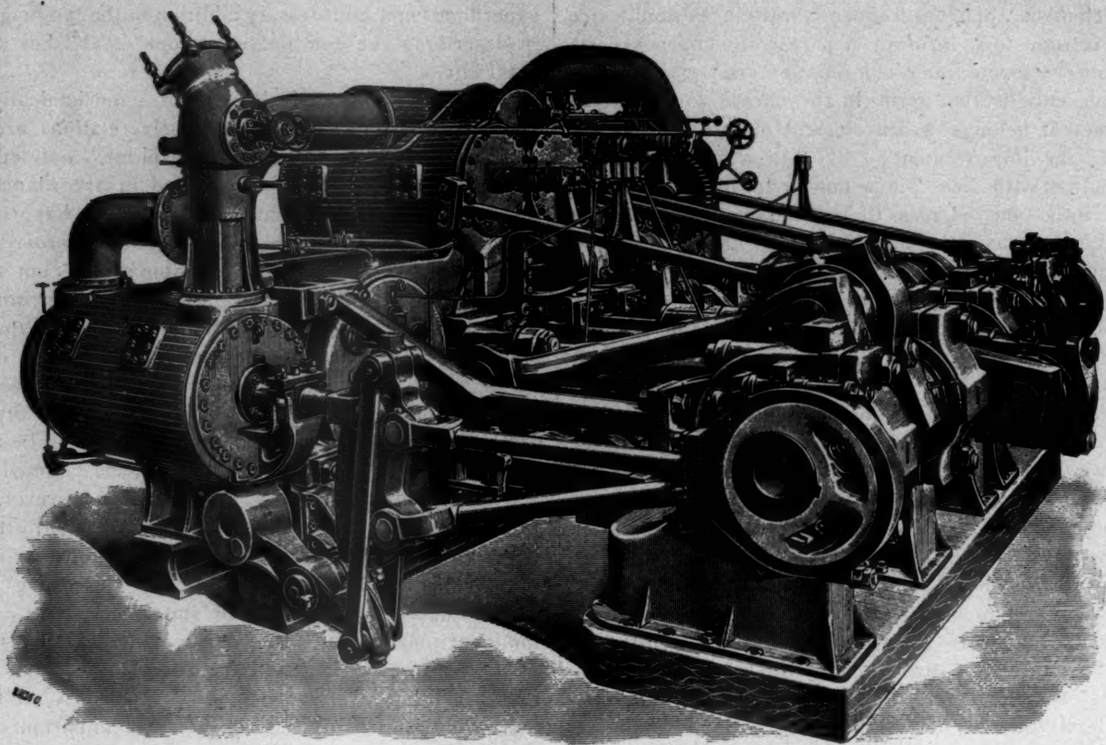


Fig. 1.

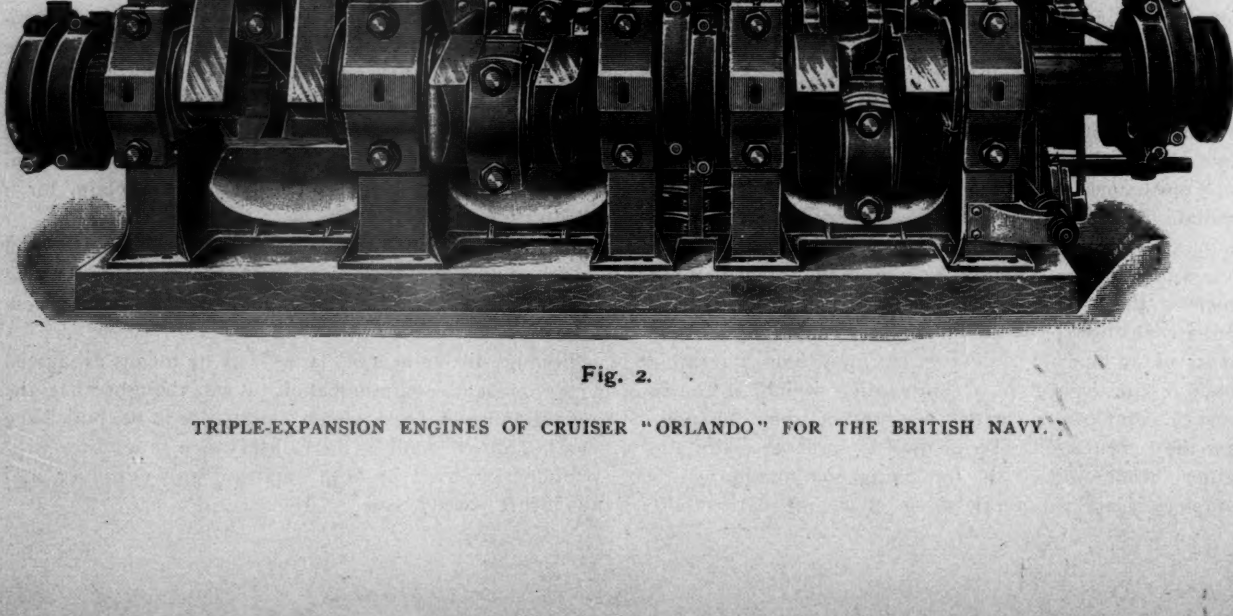


Fig. 2.

TRIPLE-EXPANSION ENGINES OF CRUISER "ORLANDO" FOR THE BRITISH NAVY.

Wire Gauges.

[Abstract of paper read before the American Society of Civil Engineers, by S. S. Wheeler, Jr.]

THE author presented with this paper a chart showing the different wire gauges now in use, and stated that there is no serious fault in some of the existing gauges; the sole difficulty is because so many gauges are in use there is confusion. The cause of this multiplicity and confusion is briefly as follows:

1. The names of the early gauges were confused, the names of makers and of towns being used indiscriminately, and each gauge being known sometimes by one name and sometimes by another.

2. The lack of an authoritative standard and accurate tools for duplicating caused the copies made by different firms to differ among themselves.

3. A large variety of new gauges of almost every possible nature have been promulgated within comparatively recent years by the men who have worked and written on the subject, as members of committees and individually.

The first two causes of confusion were more or less natural in the evolution of wire gauges, and may be considered unavoidable. The third, the introduction of new gauges, is going on at the present day, and ought to be stopped.

The result of there being no law of formation of these gauges is that among the English gauges there are more than a dozen Birmingham and many "Old English," "Old London," "Warringtons," etc., giving different values for the same number, between gauges of the same name, simply because each maker, having no fixed relation between the sizes to go by, copied some old pattern which was inaccurate from wear. The existence of this nebula of irregular old gauges is the chief cause of the unintelligent outcry against gauges. There is none of that variation between copies of either the Brown & Sharpe or the Latimer-Clark, both built upon a fixed rule.

Of the 31 existing gauges, the American, or Brown & Sharpe, the one by which copper, brass, gold, etc. (all wires except iron and steel), are measured in America, is the only one that exactly fills the requirements considered. It is a perfect parbolic curve, with a uniform reduction of 11 per cent. between consecutive sizes. The only other gauge which approaches it in the two leading requirements, a range of sizes which covers the wants of wire-users without useless intermediate sizes, and regularity of increase of the sizes, is the Latimer-Clark proposed standard. But this has not been much used, is unfamiliar, and has not been extended in sizes finer than No. 22 American gauge.

The proposition frequently brought out, that the micrometer should be used exclusively, indicates that there is a widespread failure to realize what the wire-makers want. The majority of manufacturers have neither the time, skill, nor need for the micrometer. They want a rough notch gauge adapted to sorting out the sizes which they draw, and as simple and as easy to read as possible. There is no use in recommending or condemning the micrometer. It is used, and, notwithstanding any condemnation, will continue to be used in all accurate work, as it is indispensable.

THE ENGINES OF A NEW BRITISH WAR-SHIP.

THE accompanying engravings (taken from the London *Engineering*) represent the engines of the belted cruisers *Orlando* and *Undaunted*, which were built for the British Government by Palmer's Shipbuilding & Iron Company, Limited, at Jarrow, England. The ships and engines were finished and delivered to the Admiralty last summer, and their performance so far has been very satisfactory.

These vessels, as above stated, are of the belted cruiser class, and are exactly alike; they were designed by the Admiralty. They are each 300 ft. long, 56 ft. broad, and of 5,000 tons displacement. Their deep-water draft, with all guns, stores, ammunition, coal, and crew on board, is 20 ft. forward and 22 ft. aft.

The engines were designed by the makers, and are of the horizontal type. There is a complete set of triple-expansion engines to each screw, the dimensions of the cylinders being 36 in., 52 in., and 78 in. diameter, respectively, and 42-in. stroke. There are two independent engine-rooms, divided by a transverse bulkhead stretching across the vessel. The shaft of the forward engine is thus considerably longer than that of the after engine, under the condensers of which it passes.

The framing of the engines is of steel, the main bearings and the cylinders being connected by forgings, as shown in fig. 1. The eccentrics for the high-pressure cylinder, and also those for the low-pressure cylinder, work directly on to the respective valve-spindles through the links. The eccentrics for the intermediate cylinder stand on the shaft between two bearings (as shown in fig. 2) and actuate a rocking shaft, the two upper arms of which work the valve-spindles. The reversing shaft is placed under the slide-bars, as shown in fig. 1, and is operated by a link coupled to a crank-pin in a worm-wheel and worm, the reversing engines being coupled to the shaft of the worm. These reversing engines are placed on top of the low-pressure cylinder. The valves of the high-pressure cylinder are piston valves, and those of the intermediate cylinder are of the same type.

The condensers have 12,000 square feet of cooling surface, and the condensing water is circulated by two centrifugal pumping engines to each set of main engines.

The propellers are each 14 ft. 6 in. in diameter by 18 ft. 9 in. pitch. There are four boilers, each 14 ft. 6 in. in diameter by 16 ft. 6 in. long. Each has six corrugated furnaces, 3 ft. 8 in. in external diameter. The total grate surface in the four boilers is 540 square feet, and the total heating surface 16,055 square feet. The maximum pressure is 130 lbs. per square inch.

The results of the forced draft trials of the *Orlando*, which took place on April 19 last, were as follows: Steam in boilers, 129 lbs.; indicated H.P., starboard engine, 4,313; port engine, 4,309; total indicated H.P., 8,622. The highest H.P. attained during the four hours' trial was 4,992, or 492 above what was contracted for, and the vessel attained a mean speed, by patent log, of 19¼ knots. This was, at the time, the highest speed yet attained by any armed vessel of the British Navy. On this trial the engines worked remarkably well, and the boilers gave ample steam without priming. The air pressure used in the stokeholds averaged 1¼ in. of water. On the natural draft trials on April 13, a speed of 17.25 knots was obtained with 5,617 H.P. during a four hours' run, the maximum H.P. being 5,856, or 356 above the contract, which was 5,500.

In the forced draft trials the *Undaunted* developed 4,204 H.P. in the starboard engines, and 4,398 H.P. in the port engines, and made an average speed of 19.4 knots, beating her sister ship.

A New Atlantic Steamship.

(From the London *Engineering*.)

THE Fairfield Shipbuilding & Engineering Company, of Glasgow, has just handed over to her owners, the North German Lloyd's, another splendid steamer, named the *Lahn*, which is intended for their well-known Bremen and New York line. The *Lahn* is built of steel, and has great carrying capacity; she measures 448 ft. by 49 ft. by 36 ft. 6 in. Her upper and main decks are constructed of teak, and all the deck-houses, etc., are of steel and teak. To protect the vessel from the heavy Atlantic seas, she has strongly-constructed turtle backs at both bow and stern. She has accommodation for 224 first-class, 106 second-class, and about 700 third-class passengers, and in addition there is ample accommodation provided for the ship's officers and crew, 170 in number. The first-class passengers will be accommodated on the main deck, the dining saloon being forward of the engines and boilers; and on the same deck aft there is the second-class dining saloon, which is lighted by an open well from the ladies' saloon on the upper deck, with a large skylight above on the poop. All the furniture and the cabinet and uphol-

stery work of the saloons and cabins are of a very high character, and there is every convenience for the comfort of the passengers. Accommodation for the officers is provided in the central part of the upper deck; and there is a promenade deck of about 200 ft. in length for the exclusive use of the first-class passengers. The accommodation for the steerage passengers is on the lower deck.

The engineering department calls for very special mention, inasmuch as the engines are of a new type, and the *Lahn* is the first vessel into which they have been introduced. These engines are provided with five cylinders, working upon three cranks. Two of them are high-pressure cylinders, each having a diameter of 32½ in.; then there is one intermediate, 68 in. in diameter; and there are two low-pressure cylinders, each 85 in. in diameter. The length of stroke is 6 ft. The cylinders are arranged with the high-pressure above the low-pressure one (tandem fashion), with a piston-rod common to both. The glands on the top of each low-pressure cylinder, as also the glands on the bottom of its companion high-pressure cylinder, are enclosed in a steam-tight casing, and the two pistons act as guides for each other, thus obviating the necessity for a guide-rod proper in the high-pressure cylinder. Working on the middle crank, the intermediate cylinder is placed between the others. One of Messrs. Brown Brothers' combined steam and hydraulic reversing engines is fitted to the main engines. The crank, tunnel, and propeller shafts are all made of Messrs. Vickers, Son & Company's cast-steel. The water for condensing the steam is circulated through the tubes of the condenser by two centrifugal pumps, which can also be used for pumping water out of the ship if required. As is the practice at the Fairfield Works, the propeller blades are cast of manganese bronze. Steam is supplied to the engines by six double-ended boilers and one single-ended multitubular boiler, all constructed of steel and fitted with Fox's corrugated furnaces. They are designed for a working pressure of 150 lbs. per square inch.

On the measured mile at Skelmorlie the *Lahn* attained a speed of 19.46 knots per hour, or three-quarters of a knot in excess of the speed contracted, so that with the exception of the *Umbria* and *Etruria*, she is the fastest steamer yet built for the Atlantic service, thus putting the *Alaska* in the fourth place. The engines developed 9,500 H.P. On the day preceding that on which the official speed trials were made, the *Lahn* had a preliminary run of six hours, when she attained a mean speed of 18¾ knots per hour.

Within the past seven years the North German Lloyd's have had built at Fairfield no fewer than nine magnificent steamers, representing 44,142 tons register, and engines of a total of 65,200 H.P. indicated.

NAVAL PROGRESS OF THE UNITED STATES.

THE report of the Secretary of the Navy, as submitted to Congress, naturally dwells at some length on the construction of the new vessels which are to form the Navy. The Secretary considers it matter for congratulation that during the past year three manufactures necessary to the Navy have been established in this country: Armor-plate, forgings for heavy steel guns, and the Hotchkiss rapid-fire gun. He asks authority to build three more fast cruisers of types similar to those now under construction. We have already given accounts of the new vessels now under contract; we give below some extracts of interest from the report:

COAST AND HARBOR DEFENCE.

Congress at its last session appropriated $2,000,000 for coast and harbor defence vessels. This is the only appropriation heretofore made for a new Navy, the disposition of which has not as yet been determined by the Department. A board of officers was appointed on August 18 last to consider the subject, and they have reported, but the recent unavoidable absence of the head of the Department has prevented a proper review of the matter. Bids were opened November 1 last for the construction of one first-class torpedo boat, and two bids were found to have been received; one from the Herreshoff Company, of Rhode Island, and one from the Vulcan Iron Works, of Chicago. As both offer ample guarantees, and the plans submitted with the bids in each case are satisfactory, both offers may be accepted. If so, one will be paid for out of the appropriation for harbor defence boats. Beyond this the Department is not disposed to go in the construction of these unprotected torpedo boats. It is believed that at present the facts are against them. If one should sum up the results of the naval manœuvres of the last year or two, and admit the just consequences of the facts developed at the trials, it would be admitted that the range of usefulness of the unprotected torpedo boat is certainly very limited. When they can be seen they can be easily destroyed by machine and rapid-fire guns. This rules out all day fighting. No fleet has for years in its manœuvres wasted time experimenting with the use of torpedo boats in day fighting. The electric search light has, judged by the later trials, made their usefulness at night extremely doubtful. They are of value only upon occasions when they are invisible to an enemy. Such occasions are rare. The smoke of battle might conceal them, and for a nation having large classes of fighting ships they might prove of consequence, but that is not our situation at present. Now and then an unusual night, dark and foggy, would impair the efficiency of the electric search light, and an occasion favorable for these boats be presented. But the statement of the fact that they are of value only upon rare and accidental occasions should rule them out as a reliable weapon for coast and harbor defence. A nation cannot select the nights when it will defend its harbors. The occasion when it must are chosen by its adversary. The foregoing observations only shift the problem a little. The weapon carried by the torpedo boat is the most destructive known. Torpedoes—projectiles of all kinds containing high explosives—are incomparably the most powerful known. The abandonment of the unprotected boat does not involve the abandonment of the projectile. The facts concerning the unprotected torpedo boat have not as yet been generally formulated into the conclusions above stated, but a careful study of the facts has brought about a settled conviction upon the subject which will govern the action of this Department. In what way, then, shall the high-explosive projectiles be carried so as to certainly reach the object of attack in spite of machine and rapid-fire guns? One method possibly now taking practical shape is that of the submarine boat. Elsewhere in this report will be found a reference to the latest and probably the most promising trial of this class of boat thus far had. A number of claimants are pressing different devices for these boats. In order to ascertain whether any known and certain results have yet been reached in the progress of this branch of the art, the Department has, with the aid of the chief of the Bureau of Ordnance, prepared an advertisement inviting all persons who offer to guarantee the results of their work to submit proposals to the Department on March 1 next. It will serve to sift the claims, and may result in an effective and operative submarine torpedo boat. It is reasonably certain that boats entirely submerged except as to turret, small and protected against machine-gun fire, are practicable. The pneumatic dynamite gun is a weapon claiming consideration in this connection. Its range is such as to avoid the necessity of approaching closely to the object of attack, but the Department does not feel authorized to expend anything further upon this weapon until a trial shall have been had of the guns upon the boat now being built. If this trial should be favorable to the gun, it would remove many doubts and difficulties. This will be known within the next few months. If these various devices fail, protected boats can be built of small tonnage, of light draft, proof against machine-gun fire. To sum up this matter, the Department deems it unwise to follow at present the course of the European powers in building unprotected torpedo boats. It recognizes the power of the dynamite projectile, and believes it practicable to embody it in such manner as to insure that it will reach any desired object of attack in spite of known weapons, and upon that problem it is engaged,

I find myself unable to concur in the recommendation that the single-turreted monitors be repaired and made ready for coast defence vessels. An examination of their characteristics shows that outside of the ships in our own Navy, no antagonist could probably be found against which they could stand for a moment. They were good vessels for their time, but are entirely obsolete. The Admiral of our Navy, speaking upon this matter in 1876, said :

"Our monitors are protected by only about 4 in. of laminated plates, have a speed of less than 8 knots, with a tonnage of from 480 to 1,750 tons, and are armed with smooth-bore guns that will not penetrate the 4-in. solid iron plates at 900 yards (which the lightest iron-clads of foreign nations carry, backed by oak), while the lightest foreign iron-clads average about 4,000 tons displacement, a speed of 12 knots, and their guns will send projectiles through the thickest turrets our vessels carry, and they would run over and sink our squadron of small fry with hardly a scratch on their paint work."

This comparison was made in 1876. If made in 1887, it would be still stronger. A first-class modern iron-clad could safely anchor, surrounded by a fleet of these monitors, without any danger of injury to herself, and any one of her guns could send a projectile clean through the monitor from stem to stern. It would be little less than murder to send men in these at the present time to encounter any recently built iron-clad. I appreciate fully that it is only as a temporary expedient that it is suggested, and with the thought that in the absence of anything else these might be better than nothing. This has been the theory upon which over 50, and probably 75 millions have been spent since the close of the war. It is time to stop it, and be content only with the best. If every dollar is made to count upon something of real value waste will stop, and not before.

THE PNEUMATIC DYNAMITE GUN.

The pneumatic dynamite gun has been developed by private enterprise to the point where it merits immediate attention. The constant strife for mastery between the offensive and the defensive implements of war results periodically in new devices, changing entirely existing conditions. The improvements in armor and in the range and power of guns may be said to have kept pace each with the other. But as the weak point of an iron-clad is in its unprotected bottom, invention has been directed to torpedoes and torpedo boats, and these have been almost a mania with European powers during the last five years. Meanwhile the development of the machine-gun, and the introduction of steel nettings as a protection against the approach of the torpedo boat or the torpedo have limited so greatly the range of usefulness of the torpedo boat as to have caused a considerable distrust of its availability as a weapon. The principal difficulty is that its range of torpedo fire is so short that it is obliged to approach within a few hundred feet of the object of attack, which subjects it to destruction by machine-guns. The pneumatic dynamite gun attacks the problem by a new method. The company has demonstrated that by the use of pneumatic power projectiles containing large quantities of high explosives can be fired with safety and considerable accuracy a distance of between one and two miles. Whatever destruction a torpedo can do this projectile can do if accurately placed. Against its method of attack neither nets nor machine-guns are of any considerable use. It can be fired at such a distance as to be beyond the effective range of machine-guns, and the line of flight of its projectiles escapes nets. There are questions yet to be settled before its efficiency for naval purposes can be fully determined. This invention, like every other, has its own peculiar problems to solve, but the zeal and intelligence thus far given to the development promise ultimate success. It will at once be apprehended that in order to insure immersion of the projectile (necessary to the highest destructive power of the dynamite) the line of flight of the projectile must be in the arc of a circle—similar to mortar fire. To drop a projectile at any given point with such a line of flight has hitherto been deemed impracticable. The first impression of every expert has been to reject the gun for probable inaccuracy. The company has, however, claimed that by the use of pneumatic power an absolutely accurate and determinate force is employed, and this element of uncertainty removed. The demonstration has reached this point, that, given a fixed platform for the gun, as would be the case in coast defence, and opportunity for previous experiment to determine range, projectiles can be lodged at any desired point with great accuracy. The force can be gauged to a pound. For coast and harbor defence, to be fired from land batteries, its accuracy is substantially established, but for naval purposes other elements of difficulty intervene. The movement of the vessel destroys the possibility of availing of a range previously determined by experiment. An accurate range-finder is necessary. Those hitherto employed for determining the distance of objects have required a longer base line than can be had on board ship. Other difficulties also arise for consideration. However, the problems to be solved to make it thoroughly successful for naval purposes are receiving the most zealous and persistent study, and it is believed by those interested that in time all will be worked out. This gun, developed to its present point exclusively in this country and by private enterprise, promises to be the most notable event of the year. The claim made for it is quite revolutionary. It is claimed that by increasing the caliber of these guns an accurate range of from three to four miles can be had from a land battery, and that projectiles can be used containing not less than 400 lbs. of high explosives. The present demonstration, where the accurate range of one mile is shown, renders the claim not greatly improbable. The importance of this matter is somewhat due to the fact that the guns are not difficult of construction, nor, compared to other weapons, expensive, and could be made at any one of a dozen steel manufactories with their present plant; and unless there is something very greatly wrong in the assumed destructiveness of torpedoes and high-explosive projectiles the gun must be ranked as of extreme importance.

NAVAL RESERVES.

The policy of this country has always been opposed to the establishment of large permanent naval and military organizations. This policy for a country with a great coast line and important commercial interests almost necessitates the maintenance of auxiliaries in the way of naval and military reserves. The land forces have such auxiliaries in the shape of State militia or national guards. These constitute large bodies of troops, well organized and equipped, thoroughly well trained and disciplined, ready to take the field and to become a part of a regular military establishment when required. A public feeling seems to exist for the creation of a naval reserve. Committees of the Chambers of Commerce of New York and San Francisco have passed resolutions urging the organization of such a force, as a means for providing for the coast defence and meeting the increased demands of the regular naval establishment for men and vessels upon the outbreak of war. Inquiries have also been made at the Department from cities of the Great Lakes, and meetings have been held in cities of the South endorsing the formation of such a national organization. The Department has informed itself fully of the different systems of organization for coast defence and naval reserves at present in force in foreign countries, and is prepared to formulate a general plan for a similar organization to meet the requirements and conditions of our own institutions. It should resemble in organization that of the militia or national guard, rest upon the foundation of local interest, contemplate the employment and rapid mobilization of steamers enrolled on an auxiliary Navy list, and be calculated to produce the best results upon a comparatively small national expenditure. I ask for this question the earnest consideration of Congress. It may not be out of place as a branch of this subject to call attention to one of the incidental consequences of the policy pursued by other countries in this matter of a naval reserve. In time of war troop-ships or transports are in demand. Several European governments make an annual contribution, based on tonnage, to companies constructing new vessels. The consideration to the Government is a counter-agreement, permitting the Government to take such a vessel for a transport in time of war

upon terms named in the agreement. The Government officials are also consulted as to her mode of construction, and she goes on to the naval reserve list. These payments are incidentally in the nature of a subsidy to the ship-owner, and this, with the liberal payments for Government transportation of mails, etc., keeps a large fleet of merchantmen afloat as a reserve ready for a time of war. Without ships and trained seamen there can be no naval reserve. A notable illustration of the generosity and courage with which England pushes her shipping interest is seen in the manner in which she is at this moment dealing with the trade of the Northern Pacific. It has been thus far principally under the American flag and contributory to San Francisco and the United States. The British Government and Canada together are proposing for the establishment of a line of first-class steamers from Vancouver to Japan. The subsidy is likely to be $300,000 annually—£45,000 from England and £15,000 from Canada. There will also be contributed from the naval reserve fund probably $5 per ton annually for each ship constructed for the route, which will increase the sum by probably $125,000. Under such competition it is quite easy to conjecture what will become of the American flag and our resources in the way of a naval reserve in the North Pacific.

COAST DEFENSES OF THE UNITED STATES.

THE report of the Secretary of War as submitted to Congress contains some statements with regard to coast defenses, which we give below:

FORTIFICATIONS.

The same report comes from the Pacific as from the Atlantic Coast, that our harbors are destitute of fortifications, guns, and armament of every description. San Francisco is without a gun that can be fired with safety with present charges of powder and modern projectiles. General Howard has sent to this Department a report by a committee to the Legislature of California, giving a full description of the condition of the forts in the harbor of San Francisco, and urging immediate action for coast defense. . . .

During the past year no work has been done in connection with fortifications, as no appropriation for this purpose has been made since 1885. The existing works, many of which are of value for the defense of our harbors, are in a dilapidated condition, and extensive repairs are necessary for their preservation.

The importance of immediate action looking to the reconstruction of the defenses of our sea-coast and lake frontier was fully set forth in my annual report of last year. Should the funds now asked for, $5,234,000, be appropriated by Congress, it is proposed to apply them to the construction of earthen gun and mortar batteries, which form by far the greater part of our projected defenses, and in which the question of armor is not involved; and also to the completion of our system of submarine mines, the details of which have been perfected. The works at present in contemplation are for the defense of the harbors at Portland, Boston, Narragansett Bay, New York, Philadelphia, Baltimore, Hampton Roads, Washington, New Orleans, and San Francisco. There appears to be no reason for further delay in beginning the important work of fortifying these great harbors.

Special attention is invited to the needs of the Engineer School of Application at Willett's Point. The importance of the Battalion of Engineer Troops as a Torpedo Corps, practised in the rapid and certain planting of submarine mines, cannot be too strongly enforced. In order that this school may continue to perform its work with efficiency, the appropriations requested in the estimates already submitted to Congress should be made.

ORDNANCE DEPARTMENT.

During the fiscal year ending June 30, 1887, 41,106 rifles and carbines were manufactured at the National Armory.

The question of a reduced caliber for small arms is now under careful consideration and experiment by the Department; and while the present caliber, .45, meets the demands of the service in a satisfactory manner, and was adopted fifteen years ago after extended tests, the interest awakened in the military world justifies a further examination and report upon this subject. A magazine gun has become a necessity, and during many years the Department has endeavored to find one that would give satisfaction to the Army. From what we learn of the magazine systems abroad, nothing is to be gained by haste, and the Springfield rifle must continue to serve our purpose until a magazine gun that will do credit to the inventive genius of our people is adopted. It is to be observed that under the existing law, Revised Statutes, section 1,672, only the Springfield guns can be manufactured by this Department. We are unable, therefore, to make magazine guns, and can only test and examine the magazine guns and systems brought to the Department by dealers or inventors. It is very desirable that this statute should be so far modified that we can purchase or manufacture magazine guns for experiment and trial. Large appropriations for ammunition and target material are asked for. A matter so necessary to the effectiveness of our small army deserves the favorable consideration of Congress.

In view of the success attained by our steel-makers, it is apparent that the assurance that the outlay for the necessary plant will prove remunerative is all that is required to produce in this country the largest gun forgings of suitable quality. It is believed to be of vital importance that appropriations be annually made by Congress until our present need of modern guns is supplied and the aid that our steel industry demands is assured. As a step in this direction an appropriation of $1,500,000 for the forgings of 8-in. and 10-in. B. L. steel guns has been recommended in the estimates. This sum would procure the steel for about fifty 8-in. and forty 10-in. guns, and should be made available until expended. A trial of the improved Powlett carriage should be authorized. It was first tried by this Department, and its favorable action induced further trial by the Navy Department. The conditions differ so much in the two Departments that appropriations for renewed trials by this Department are recommended.

The recommendation of General Schofield, that each artillery post be furnished with the means for instruction in modern ordnance, is a very important one, but the Department is unable to comply with the request, as we have no guns suitable for such target practice and technical instruction. In no branch of the Service is technical instruction and daily experiments and practice in the use of its weapons more demanded than in the artillery. Infantry can be rapidly organized and soon made serviceable; but the trained and well-instructed artillery soldier, whether officer or enlisted man, is only obtained by long and patient work. It is earnestly hoped that, if guns cannot be had for fortifications, appropriations can be made for the purchase or manufacture of enough guns to employ the artillery and fit them for any emergency. The light batteries in this division are said to be in good condition. It is probable that new 3.2-in. steel B. L. rifled guns, with proper carriages, will be put in their hands during the coming season. A concentration of these batteries may be made at Fort Niagara, N. Y., which affords better facilities for their work than any other place in the division, when that post can be prepared for their reception.

The Rifles of Modern Armies.

(From the London *United Service Gazette*.)

THE decision to adopt a magazine rifle has not been arrived at any too soon. Germany, France, Italy, Austria, Switzerland and several other continental nations have already adopted it; and although the Martini-Henry is a fairly good weapon, considered as a single loader, we shall, so long as we possess nothing better, be far behind the vast majority of the military powers.

It may here be pertinent to give a list of the rifles which are now in actual use in various countries. These are as follows:

Afghanistan, Martini-Henry; Argentine Republic, Remington; Austria, Werndl, Mannlicher (M. 85); Belgium, Albini-Braendlin; Brazil, Comblain; Chili, Kropatschek; China, Remington, Snider, Hotchkiss, etc.; Colombia,

COMPARATIVE TABLE OF MODERN RIFLES.

System.	Weight of Rifle.		Caliber.	Weight of			Rifling.		Velocity in feet per second.		
				Powder.	Bullet.	Cartridge.	No. of Grooves.	Twist in Calibers.			
	lbs.	oz.	Inch.	Grs.	Grs.	Grs.			Muzzle.	1,000 yds.	2,000 yds.
Werndl	9	13½	.433	77	370	610	4	1 in 50	1,439	600	328
Martini-Henry	8	12	.45	85	480	766½	7	1 in 49	1,253	662	388
Gras (M. 74–80)	9	4	.433	81	386	676	4	1 in 50	1,430	642	346
Mauser (M. 71–84)	10	2	.433	77	386	663	4	1 in 50	1,410	628	335
Vetterli	10	8	.414	55	312	465	4	1 in 63½	1,427	593	302
Kropatschek	9	14½	.433	81	386	676	4	1 in 50	1,430	621	315
Jarmann	10	1½	.397	77	337	620	4	1 in 55	1,536	675	377
Berdan	9	4	.42	77	370	610	6	1 in 50	1,444	645	353
Springfield	9	5¼	.45	70	500	706	3	1 in 49	1,350	675	404
Remington (M. 71)	9	0	.433	77	386	638	6	1 in 59	1,340	630	325
Enfield-Martini	9	6	.402	85	384	680	7	1 in 37½	1,570	719	424
Mannlicher (M. 85)	9	8½	.433	77	371	656	4	1 in 68½	1,437	622	315

Remington ; Denmark, Remington ; Egypt, Remington ; France, Gras, Lobell, Kropatschek ; Germany, Mauser, Mauser (M. 71–84) ; Great Britain, Martini-Henry, Snider ; Greece, Gras (M. 74) ; Holland, Beaumont-Chassepot (modified) ; Italy, Vetterli, Vitali-Vetterli, Freddi (?) ; Japan, Murata ; Madagascar, Remington, Snider ; Mexico, Lee ; Montenegro, Kenka, Dreyse ; Norway and Sweden, Jarmann ; Persia, Chassepot ; Peru, Beaumont (modified) ; Portugal, Guedes (Kropatschek) ; Russia, Berdan (M. 71) ; Servia, Peabody-Grun ; Spain, Remington (M. 71) ; Switzerland, Vetterli ; Turkey, Martini-Henry, Peabody-Martini ; United States, Springfield, Lee ; Uruguay, Remington.

Some of the more important of these modern breech-loaders (leaving aside for the present the magazine question) are compared in the accompanying table.

Upon the whole, if we regard these weapons merely as single-shot rifles, the Enfield-Martini, the Springfield, and the Jarmann may be taken to be the best of the 12. The real superiority, however, of the Enfield-Martini becomes more apparent than ever when we compare the heights of the trajectories of the three selected rifles at various ranges. These are as follows :

HEIGHT OF TRAJECTORIES IN FEET.

	500 Yards.	1,000 Yards.	2,000 Yards.
Springfield	8.5	46.8	343.0
Jarmann	7.2	42.9	348.0
Enfield-Martini	6.7	39.0	298.4

But even the Enfield-Martini, good as it is, is a very inferior weapon as compared with three foreign rifles of recent invention. These are the Lobell, which has been adopted by the French Government, and which appears to be a combination of the Kropatschek and Hebler systems, the Pieri, and the Hebler. The Enfield-Martini is also slightly inferior to the Freddi, a recoil rifle, which the Italian government proposes to adopt. Of these powerful new weapons we are only able to give the meagre details that follow, for great secrecy is observed with regard to the performances of each of them. For purposes of comparison we put the Enfield-Martini by the side of them :

	-	Rifle.	Weight of Powder.	Bullet.	Twist in Calibres.	Muzzle Velocity.
	inch.	oz.	grs.	grs.		ft. p. sec.
Enfield-Martini	.402	150	85	384	1 in 37½	1,570
Freddi	.315	116	83	225	?	1,640
Hebler	.296	158½	83	225	1 in 15½	1,968
Lobell	.307	?	?	?	?	2,034
Pieri	.323	?	83	?	?	2,057

This table certainly makes it appear that reduction of caliber and of weight of bullet, without proportionate reduction of weight of powder charge, and with an increased twist in the rifling, gives a highly increased velocity ; and it was probably with these statistics before them that the Government the other day decided that the Enfield-Martini was not good enough for the British army, and that the service required not merely a magazine rifle, but a magazine rifle with a caliber of about .31. The British bullet of the future will be, therefore, no thicker than an ordinary lead-pencil. So much for modern military rifles regarded simply as single-loading weapons.

Many of the rifles of which we have already spoken are magazine or quick-firing rifles. The exact type of this class of weapons which is to be adopted in Great Britain does not appear to have yet been determined, but it is understood to be either the Improved Lee or the Lee-Burton. Both of these have detachable magazines, and the breech-bolt mechanism is the same in each. All the modern magazine rifles are, in fact, constructed on the breech-bolt system, though the details vary somewhat in almost every case. It is in the form and position of the magazines that the greatest divergencies prevail. As Captain W. H. James has classed them, magazines may be divided into—(1) those in the butt, (2) those under the barrel, (3) those over the barrel, and (4) those under the breech. "No nation," he says, "has adopted the first and third forms. Germany, France, Switzerland, Sweden, and Portugal have the second, with magazines under the barrel, in the systems of Mauser, Kropatschek, Vetterli, Jarmann, and Kropatschek-Guedes respectively." These guns are all difficult to load, and the balance of the piece is altered each time the gun is fired. The chief objection to the first class lies in the difficulty to load. The third class is objectionable because the aim is obstructed by the magazine over the barrel. The best position is that of the fourth class, with the magazine under the breech, as in the Mannlicher, Schulhoff, Pieri, Lee, and Improved Lee.

The Lobell, the new French rifle, has its magazine under the barrel ; but, save that the receptacle contains eight cartridges, and that smokeless powder is used, little is known about it.

Of the new German rifle, Mauser (M. 71–84), there is more to be said. It is sighted up to 1,600 meters (1,750 yards), and the barrel is of mild cast steel, slightly diminishing in thickness at the muzzle. The rear end of the bore is considerably enlarged to serve as a cartridge chamber, and it is closed by the breech bolt. The rifle is 4 ft. 3 in. long, and, with the bayonet, 5 ft. 11 in. When empty it weighs 10 lbs. 2 oz., and when loaded 11 lbs. The bayonet weighs 1 lb. 10 oz. The magazine, which will contain eight cartridges, is a tube of thin sheet steel, inside of which, and fastened to the forward closed end, is a spiral spring. This spring forces down the cartridges to a point below the breech, where, when the bolt is withdrawn, the lowest one is seized in a spoon and carried upward until the point of the bullet is in position to enter the cartridge chamber. Meantime the magazine is closed by a lip which is affixed to the lower side of the mouth of the spoon. The pushing forward of the breech bolt drives the cartridge home and simultaneously depresses the spoon, while it also sets free a check which prevents another cartridge entering the spoon until the bolt is once more withdrawn. This withdrawal pulls out the empty cartridge by means of an extractor which forms part of the end of the bolt. The check above spoken of may also be set in action independently, and the rifle can then be used as a single loader. Blank cartridges made with a hollow wooden bullet painted red are served out for sham fights and practice. The service cartridge is 3.07 in. long. Experiments have recently been made with an improved cartridge containing 89½ grains of powder and a steel-covered bullet.

The new Austrian rifle, Mannlicher (M. 85), carries its

magazine, a detachable one, under the breech, and the manipulation of the breech bolt simply involves a straight backward and forward motion, so that the gun can be fired and loaded without removing it from the shoulder. Each magazine holds five cartridges, and, when destined for use, is placed in a hollow frame beneath the breech. This frame has bent rocking levers which project into the magazine, entering from the rear and below. The levers act as carriers for the cartridges, and feed them up to a point at which they can be acted upon by the forward motion of the bolt, and so thrust into the barrel. The ammunition is kept packed in magazines, each of which is a tin case, costing about 1d., and weighing 385 grains. The disadvantage of the rifle is that it cannot be used as a single loader.

The Improved Lee is free from this grave drawback. Like the Mannlicher, it has a detachable magazine which holds five cartridges; but it can be used as a single loader, whether the magazine be attached or not. A full magazine can be substituted for an empty one in two seconds. Like the Mannlicher, the Lee can be fired again and again without removing it from the shoulder. It is now almost certain that some modification of this weapon will be adopted for the use of the British army.

Various guns which utilize the recoil of each discharge for the purpose of ejecting the empty cartridge, and even substituting a full one, and in some cases firing it, might also be noticed. Captain Freddi has invented one, which the Italian Government has proposed to adopt, and which seems to be an excellent weapon. The Freddi system only, however, makes a restricted use of the recoil, which is employed merely to eject the empty cartridge, open the chamber, and cock the rifle. It is difficult to explain the mechanism without the aid of diagrams; but in practice the Freddi is worked as follows: From a cartridge box, which hangs at the side of the rifle, the soldier takes a cartridge and inserts it in the receiver as in an ordinary single loader. He then brings the gun to the shoulder, fires it by pressing the trigger with his forefinger, introduces a new cartridge, and with his thumb presses a button, which closes the breech. He can fire 24 rounds in a minute, and he can always use the gun as a single loader by working the bolt himself instead of letting the recoil work it for him. The weight of the gun is only 7 lbs. 4 oz., the complete cartridge weighs but 398 grains, and, as we have already seen, a muzzle velocity of 1,640 ft. per second is attained. When we consider that the new Mauser weighs 10 lbs. 2 oz., that its cartridge weighs 663 grains, and that its muzzle velocity is only 1,410 ft. per second, some of the advantages of the Freddi become immediately apparent. The weight of the Mauser (M. 71-84) and 100 cartridges is about 19 lbs. 9 oz.; that of a Freddi and 100 cartridges is only about 12 lbs. 14 oz. Indeed, a man armed with a Freddi and carrying 200 cartridges would be less heavily weighted than a man armed with a Mauser and carrying only 100 cartridges. From the point of view of the marching soldier, if from no other, this consideration is a very important one. The relative lightness of the Freddi cartridge is due solely to the caliber of the rifle, being .315, as compared with the Mauser's .433. The relative lightness of the rifle is due to the fact that the gun, and not the soldier, has to take the force of the recoil. In ordinary rifles it is necessary to make the weapon heavy in order that the soldier may be assisted in supporting the shock; but that necessity not existing in the Freddi, the gun can be made as light as possible.

Railroads in Japan.

[Report of T. R. Jernigan, U. S. Consul at Osaka, Japan, to the State Department.]

THE Government of Japan has recently issued a series of regulations on the subject of private railway enterprises. Before considering the more important provisions of these regulations, a brief synopsis of the history of railroads in Japan may be interesting.

Commodore Perry was the first to give the Japanese a practical illustration of the idea of a railroad, but it was not until 1870 that the first railroad was introduced into Japan with a view to profit and for commercial purposes.

It was during the year 1870 that the first rail was laid of the road now connecting Tokio and Yokohama. This road was opened in 1872; it is 18 miles long, and cost nearly $160,000 per mile.

The second line was constructed in 1876, and runs between Hiogo and Kioto, *via* Osaka. It was, and is now, the purpose of the Government to connect by rail the new and old capitals, Tokio and Kioto, but this larger project yielded to the pressing demands of trade, which, originating at Osaka, the great commercial center, pointed out the necessity of a line to the open port of Hiogo.

The civil war of 1876 (called the Satsuma rebellion) interrupted all railroad enterprises, and it was not until 1880 that the line under consideration was completed from Kioto to Otsu, on the south-eastern corner of Lake Biwa. This line from Hiogo to Otsu is 58 miles long; its cost has been nearly $140,000 per mile.

Since 1880 there has been considerable activity in building and projecting railroads in Japan. In addition to the two roads named above, there are opened for traffic the following: Tsuruga-Ogaki, 49 miles; Tokio-Mayebashi, 68 miles; Shinagawa-Akebani, 13 miles; Omiya-Utsonomiya, 5 miles; Takasaki-Yokogawa, 18 miles; Handa-Nagoya (including extension to Kiyosu), 30 miles; Naoetsu-Sekiyama, 18 miles. This makes 277 miles now open.

The following lines are now under construction or in contemplation: Ogaki to Kiyosu, 10 miles; Yokogawa to Sekiyama, 80 miles; Yokogawa to Nagoya, 120 miles; Nagahama to Ishibashi, 40 miles; Utsunomiya to Sendai, 150 miles; Sendai to the port of Shiogawa, 10 miles; a total of about 410 miles.

The lines for all these roads have been surveyed and the roads built by foreign engineers; but on examining the list I find that American engineers and mechanics have been virtually ignored.

Even now, when public opinion in Japan is almost wholly occupied by the subject of railroads, and no less than 34 new railroad projects have been started within the last six months, 21 of which involve an aggregate capital of $48,765,000, I am unable to perceive any change in this direction favorable to the United States.

The imperial ordinance entitled "Private Railroad Regulations" contains 41 articles, and might be termed by lawyers a misnomer. An examination of some of its articles will show that such a name would not be misapplied, for while the title of the ordinance implies that railroad enterprises might be undertaken by private individuals, it is clear that no such enterprises could flourish a day that did not have the full sanction of the Government.

The application for the construction of a road has to be made by no less than five persons, who shall jointly through the municipal Government in the jurisdiction of which it is intended that the head office of such railroad shall be situated, transmit to the central Government, in the form of a petition for leave to establish the proposed railroad company, such information as is necessary to explain the undertaking.

After the petition has been submitted, should it appear that the proposed undertaking will interfere with any existing railroad, or that the local condition, etc., do not show any necessity for the construction of the new line, then the petition will not be granted; otherwise a charter authorizing the work of constructing the line and incorporating the company will be issued, after having received the approval of his Imperial Majesty.

If the charter should not be obtained, it will not be competent for the promoters to raise any of the capital by means of shares, or, in the name of the company, to commence the work of constructing the railroad.

The work on the railroad must be begun within three months from the date of the charter, and finished within the time fixed by said charter. If an extension of time be desired, it must be made through the municipal Government within two months, but such extension cannot amount to more than half the period originally fixed. The gauge, unless specially sanctioned to the contrary, shall be 3 ft. 6 in.

No company can alter its rules or methods of working without the sanction of the Government, and rules and

rates of freight or charges for passengers must be fixed under, and all alteration or changes submitted to, the approval of the Chief of the Railroad Bureau, and so must all changes in the hours of starting and arriving, and the number of trains run, etc.

When a charter for a railroad is granted only for a special period, the Government shall have the right at the expiration of such period to buy up the line and its accessories, and the price at which such purchase shall be made shall be a price to be calculated from the average price of the shares during five years previous to the date of purchase.

Before any charter can be granted detailed plans and estimates must be submitted to the Railroad Bureau and approved by the experts of that office. Other exceptional powers of inspection are reserved to the Railroad Bureau, such as discretionary inspection during construction, compulsory inspection and approval on completion of the work and before traffic is commenced, and discretionary inspection while the railroad is in use. The tendency of such a system of espionage is to discourage the formation of private companies, which is greatly increased when it is proposed to subject honest enterprise to the inconvenience of commencing the work of construction within three months from the date of the charter, with a possible extension of not more than a month and a half. The above compilations show that the purpose of the Government is to retain in theory, as well as practice, control of all the railroads in Japan.

Another subject of importance to American workshops is now claiming the attention of the press in Japan.

The *Jiji Shimpo*, an able and independent native journal, recently referred to the superior construction of American rolling stock and American workshops. Enlarging upon the subject in its relation to English workshops, the *Japan Mail*, an English journal, asserts that experience in Australia has proved the superiority of English locomotives over American.

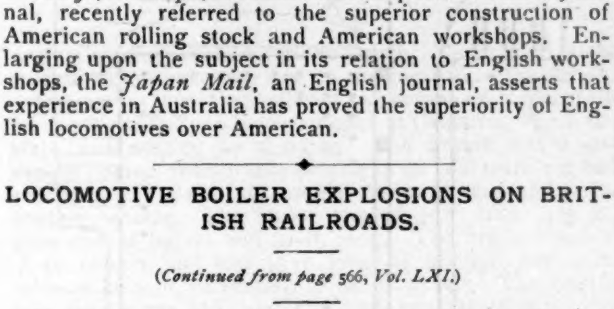
LOCOMOTIVE BOILER EXPLOSIONS ON BRITISH RAILROADS.

(*Continued from page 566, Vol. LXI.*)

We continue below the condensed summary of the reports made to the British Board of Trade by its Inspectors on the explosions of locomotive boilers on the railroads of that country.

INSPECTORS' REPORTS.

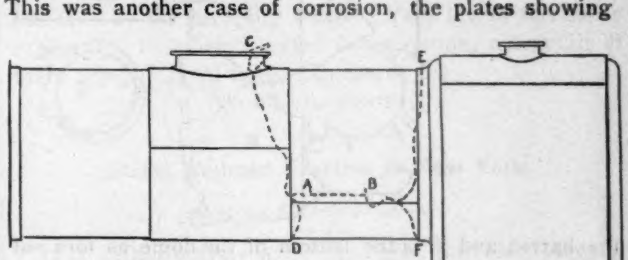
May 5, 1862, the locomotive of a freight train on the London & Northwestern exploded its boiler while shifting cars at Harrow. The explosion took place on a siding, just after the engineer had opened the throttle to start. The engine was a heavy one with 18×24 in. cylinders and six 60-in. wheels, all coupled. The boiler was 52 in. diameter of barrel and 14 ft. 2 in. long; it had 237 tubes, $2\frac{1}{8}$ in. diameter. The engine was nine years old; it had been damaged in a collision three years before, and when repaired the boiler had received a new set of tubes. The usual working pressure was 120 lbs., and there were three



safety-valves, set to that pressure. The explosion killed the fireman and injured the engineman badly. The barrel of the boiler opened just above the seam in the middle ring, and the upper plates were torn off and thrown over to the right, most of the tubes being torn out and thrown in the opposite direction. Examination showed that the plates were badly corroded in two or three places along the seams. The weakest spot was on the line *A B* in the accompanying diagram, where the plate had been reduced from its original thickness of $\frac{1}{2}$ in. to a little over $\frac{1}{16}$ in. It was at this point that the barrel gave way, and the weakness caused by the corrosion was the cause.

November 8, 1862, a locomotive on the Great Western exploded its boiler while standing in the shed at Paddington station. Fire had been started about two hours before. The explosion killed three cleaners who were at work in the shed. The fire-box remained intact, but the barrel was torn away from it and was broken into several pieces, some of which went through the roof, one landing 300 ft. away. The engine was lifted from the track and turned completely around. This was a heavy passenger engine with 18×24 in. cylinders, one pair of 8-ft. drivers, and six 42-in. bearing wheels. The barrel of the boiler was 57 in. diameter and 10 ft. 9 in. long. It was of $\frac{1}{2}$-in. iron plates and had 303 brass tubes, 2 in. diameter. There was no evidence to show that water was low or the safety-valves defective, and steam had not reached 120 lbs., the point at which the valves were set. There was, however, extensive corrosion and pitting, chiefly along the seams on the lower part of the barrel. The Inspector makes this and the previous explosion occasions for urging more frequent tests of boilers and more care in inspection and in watching for evidences of corrosion.

May 30, 1864, the boiler of the locomotive of a passenger train on the London & Northwestern road exploded just as the train had stopped at Overton station. The engineman and fireman were slightly hurt. One ring was torn completely off the barrel, and the force of the explosion moved a shed standing by the track. Just before the explosion the gauges showed plenty of water in the boiler and about 100 lbs. steam pressure. No leak had been noticed about the boiler. The engine had 16×21-in. cylinders and one pair of drivers 69 in. diameter. The boiler was of $\frac{3}{8}$-in. iron, 47 in. diameter of barrel, and 10 ft. long. This was another case of corrosion, the plates showing



deep pitting. In the accompanying diagram the line *A B* shows the point of greatest corrosion and consequent weakness. The irregular lines *C D* and *E F* show the lines of fracture, and the space between them marks the part of the plate torn off by the explosion. The Inspector in this case again urges the necessity of frequent inspection, and the danger of allowing boilers to go without examination as long as this one had been left. He refers also to the corrosion resulting from the chemical and galvanic action of the iron and copper used in boiler construction. As to construction, he makes the following recommendations:

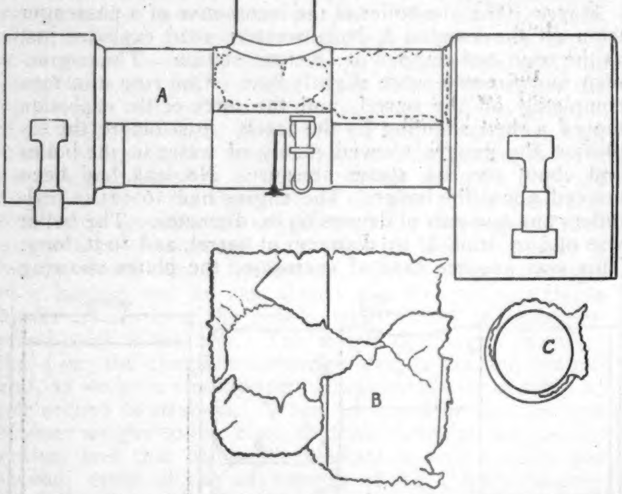
"1. The barrels should be made more perfectly cylindrical by the use of butt-joints and cover-strips, in place of the lap-joints commonly used.

"2. The longitudinal joints should be placed in all cases above the water-line instead of below it, so as to prevent the risk of corrosion from the different actions (chemical and galvanic) before referred to; there is no necessity for more than one longitudinal joint in each ring.

"3. The boiler should be firmly attached to the framing at one end only, the other end being allowed to slide backward and forward to allow for changes of temperature, as is now frequently, but by no means always, done.

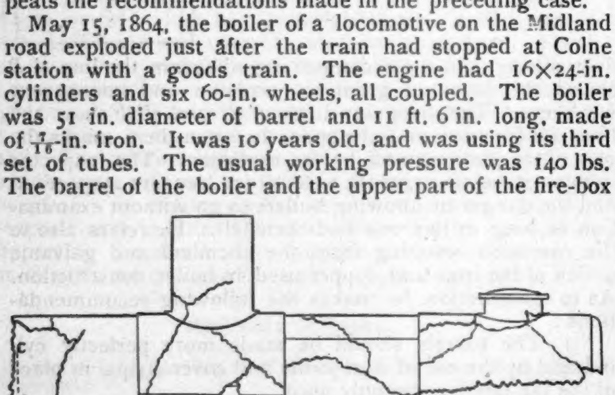
"4. The barrel should be strengthened at the vertical (or transverse) joints and at intermediate intervals, either by the addition of belts or by the use of plates rolled thicker in the middle as well as at their edges. A locomotive boiler thus reinforced in a proper manner would leak when the plates had been eaten through by corrosion between the strengthening belts, but could never explode."

May 9, 1864, a boiler exploded on the locomotive of a passenger train on the Metropolitan line of the Great Northern road, just as the train was stopping at Bishop's Road station. The engineman, fireman, a brakeman, and a passenger were badly hurt. The roof of the station over the engine was blown off. The engine in this case had 16×22-in. cylinders and six 60-in. wheels, all coupled. The boiler barrel was of $\frac{3}{8}$-in. iron, and was 45 in. diameter and 10 ft. long. The working pressure was 120 lbs., and there was no reason to believe that it had been exceeded. The boiler in this case was 14 years old, and had had three sets of tubes, the last having been in use 14 months. Slight repairs had been made, and two patches put on at the same time the last set of tubes were put in. The accompanying diagram shows the boiler, *A* being a general view of it, the dotted lines showing the lines of fracture. *B* is a sketch of the plates torn off the top of



the barrel, and *C* is the bottom of the dome as torn out from the plate *B*. The Inspector believes this to have been another case of weakening from corrosion, and repeats the recommendations made in the preceding case.

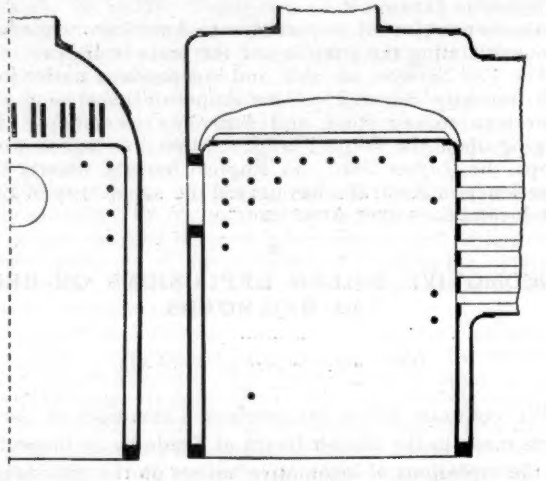
May 15, 1864, the boiler of a locomotive on the Midland road exploded just after the train had stopped at Colne station with a goods train. The engine had 16×24-in. cylinders and six 60-in. wheels, all coupled. The boiler was 51 in. diameter of barrel and 11 ft. 6 in. long, made of $\frac{7}{16}$-in. iron. It was 10 years old, and was using its third set of tubes. The usual working pressure was 140 lbs. The barrel of the boiler and the upper part of the fire-box



were torn off and blown into about 20 pieces. The accompanying diagram shows the fractured portion, the irregular lines showing the lines of fracture. The smoke-box and fire-box remained attached to the framing. This was another case where there had been extensive corrosion, the weakest point being along the longitudinal line of rivets.

It will be noticed that three serious explosions have occurred on different roads within a few days, all from the same cause. The Inspector makes the same recommendations in each case.

September 16, 1864, the boiler of a locomotive exploded at Camden Road station on the North London road, just as the train was starting from the station. The engineman was badly hurt and the fireman killed. The engine was a tank engine with 15×22-in. cylinders, four coupled wheels 63 in. diameter, and leading wheels 42 in. diameter. The boiler was 10 years old, outside shell of iron, and copper fire-box. The explosion occurred in the fire-box, and commenced at the angle formed by upper and rear sides of the left-hand copper plate. This plate was torn off irregularly, blown inward, and partially bent over against the tube-sheets. The sudden and violent escape of steam lifted the engine up and turned it over on the left side. The copper plates were stayed to the outside shell by copper stays $\frac{7}{8}$ in. diameter spaced $4\frac{1}{2}$ in. apart in each direction. In the side-sheet there were 108 of these stays, of which 89 remained attached to the iron shell, their screwed ends being torn out of the copper sheet. The other 19 remained attached to the copper plate, and all of these showed signs of old flaws or breaks. Five of the stay-bolts in the back sheet also gave way. The accom-

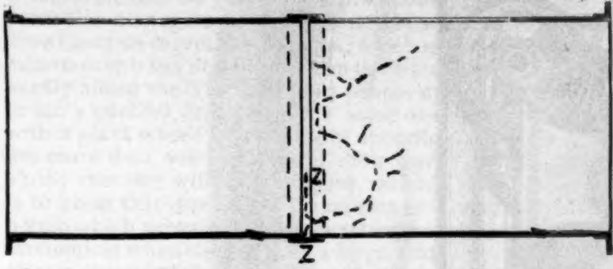


panying diagrams show a longitudinal section and a half cross section of the fire-box, the position of the broken stay-bolts being shown by the black dots. The Inspector finds in this case that the rivet-heads on the stay-bolts had been generally burned away on the inner side of the fire-box. He believes that the explosion was due partly to the giving way of the stay-bolts and partly to the absence of hanging stays to connect the crown-bars to the outer shell of the boiler.

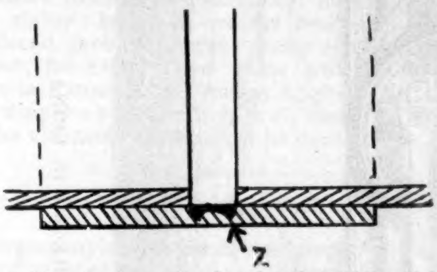
January 14, 1865, the boiler of a Great Northern locomotive exploded in the shops at Peterboro. The engine was off its wheels at the time, and the boiler had just been overhauled and several patches put on the fire-box. It was filled with water and steam raised in order to test it; just as the pressure reached 125 lbs. it exploded, the two forward rings of the barrel being torn off, leaving the rear end almost intact. The roof of the building was blown off and several other engines in the shop damaged. In this case the boiler was 48 in. diameter of barrel and 10 ft. long. The shell was of $\frac{7}{16}$-in. plates, the rivets $\frac{3}{4}$ in. diameter, spaced $1\frac{3}{4}$ in. apart. Two extensive cracks or furrows were found in the fractured plates, and they undoubtedly began to give way at those weak points. As in several cases heretofore referred to, these furrows had apparently been started by the calking tools, and had been enlarged by corrosive action.

February 12, 1865, the boiler of a locomotive on the Great Western road exploded at Leominster while the engine was waiting to start with a goods train. The engine had 15×24-in. cylinders, four coupled 60-in. drivers, and 42-in. leading wheels. The boiler was 44 in. diameter of barrel

and 10 ft. long. The engine was built in 1849; in 1860 the fire-box was altered to burn coal, and at that time a belt 7 in. wide and $\frac{7}{16}$ in. thick was added round the middle of the barrel; but at the time a space of $1\frac{1}{4}$ in. was left between the edges of the plates. The accompanying sketches show the barrel of the boiler, with the lines



of fracture, and (on a larger scale) the peculiar method in which the extra plate was put on. This space left between the plates was a direct invitation for corrosion to begin,



and its working is shown in the sketch. There is no doubt that the boiler gave way first on the line *Z Z* on the sketch.

January 1, 1866, the boiler of the engine of a coal train on the Blyth & Tyne road exploded at Gosforth, where the train was waiting on a siding. The engine was a passenger engine, temporarily employed on coal work; it had 16×24-in. cylinders, four coupled 66-in. drivers, and 54-in. leading wheels. The boiler was of $\frac{1}{2}$-in. iron, $45\frac{1}{2}$ in. diameter of barrel and 10 ft. long. The fire-box was of $\frac{7}{16}$-in. copper, and was 45 in. long, 64 in. high, and 40 in. wide at bottom, increasing to 44 in. at top. The engine was four years old, and had had general repairs nine months before the explosion, when a new set of tubes was put in. In this case the fire-box gave way on the left side, the side-sheet being torn off and blown out; the force of the explosion lifted the engine and turned it over on one side. About one-fifth of the crown-sheet was carried away with the side-sheet. The Inspector found that the copper sheet was badly worn, and that the heads of many of the stay-bolts had been burned off, and held that these defects caused the explosion. He also considered that there had been neglect in not inspecting the boiler more carefully, as such inspection might have revealed the weakness of both sheet and stays.

January 31, 1868, the boiler of a passenger locomotive on the Lancashire & Yorkshire road exploded just after the train had stopped at Halshaw Moor. The engine had 15×20-in. cylinders, one pair of 70-in. drivers, and 42-in. leading and trailing wheels. The fire-box was of copper, the sides and top being in one $\frac{1}{2}$-in. plate 12 ft. 9 in. long in all; the back sheet was also $\frac{1}{2}$ in., with a thickening piece $\frac{5}{8}$ in. thick around the fire-box door; the tube-sheet was $\frac{7}{8}$ in. thick. The stay-bolts between the fire-box and outer shell were 1 in. diameter and spaced 5 in. apart. The engine was 20 years old; it had been several times repaired, the last time about a year before the accident. At that time a patch was put on the back sheet of the fire-box. The fire-box gave way, the side-sheet and part of the crown-sheet being doubled up together, the stay-bolts in the side-sheet being either drawn through the copper sheet or broken off. Investigation showed that many of the stay-bolts had their heads burned off, and that the copper sheets had been worn down in places to $\frac{1}{4}$ in., $\frac{3}{16}$ in., and in one place (where the fracture probably started) to $\frac{1}{8}$ in. in thickness. This weakness caused the explosion, which might have been prevented by proper inspection of the boiler.

October 25, 1870, the boiler of a passenger engine on the Manchester, Sheffield & Lincolnshire road exploded just as the train was starting from Deepcar station. A piece of the outer crown-sheet about 2×4 ft. was torn out and thrown up on a bank 35 ft. away, and the side-sheets were also torn out, one of them being found 500 ft. off. Inspection of the plates showed a deep flaw in one of them, where it began to give way, which had been in the plate apparently when it was first put in the boiler. A sufficient safety test would probably have exposed this flaw.

January 29, 1871, the boiler of the engine of a passenger train on the Northeastern road exploded while the engine was standing at Northallerton. The engine was 24 years old, and had been last repaired a few months before, when a new steam-pipe was put in. The whole of the barrel of the boiler was torn away from the smoke-box and fire-box, and the engine was almost destroyed. The barrel plates were picked up in 9 pieces. The boiler was of elliptical form, 44 by 41 in., the barrel being formed of six $\frac{3}{8}$-in. plates running its full length, with joints overlapping about 2 in. An old flaw was found in the angle-iron connecting the barrel with the fire-box, but the fracture apparently did not start there. The Inspector thinks it "difficult to assign the exact cause of the failure of this boiler at the time it occurred; but it is fair to assume that it was in some unexplained way connected with the repairs which it had just undergone. Considering its age and faulty form, it was a great mistake to have sent it out to work after repair without having applied to it a pressure test, particularly as it was three years since the last test had been applied. It is also to be noted that a margin of 30 lbs. between the test and working pressure is not sufficient for safety."

For 1871 the railroad companies were required for the first time to make reports of all the accidents occurring. In that year two cases of accidents to boilers were reported. One is noted above; the other was not considered worth a special inquiry, as it was only a case of the collapse of a tube, an engineman having been slightly scalded in the face by the escaping steam. Very few of the boiler explosions, however, escaped investigation, nearly all of them being referred to the Inspectors.

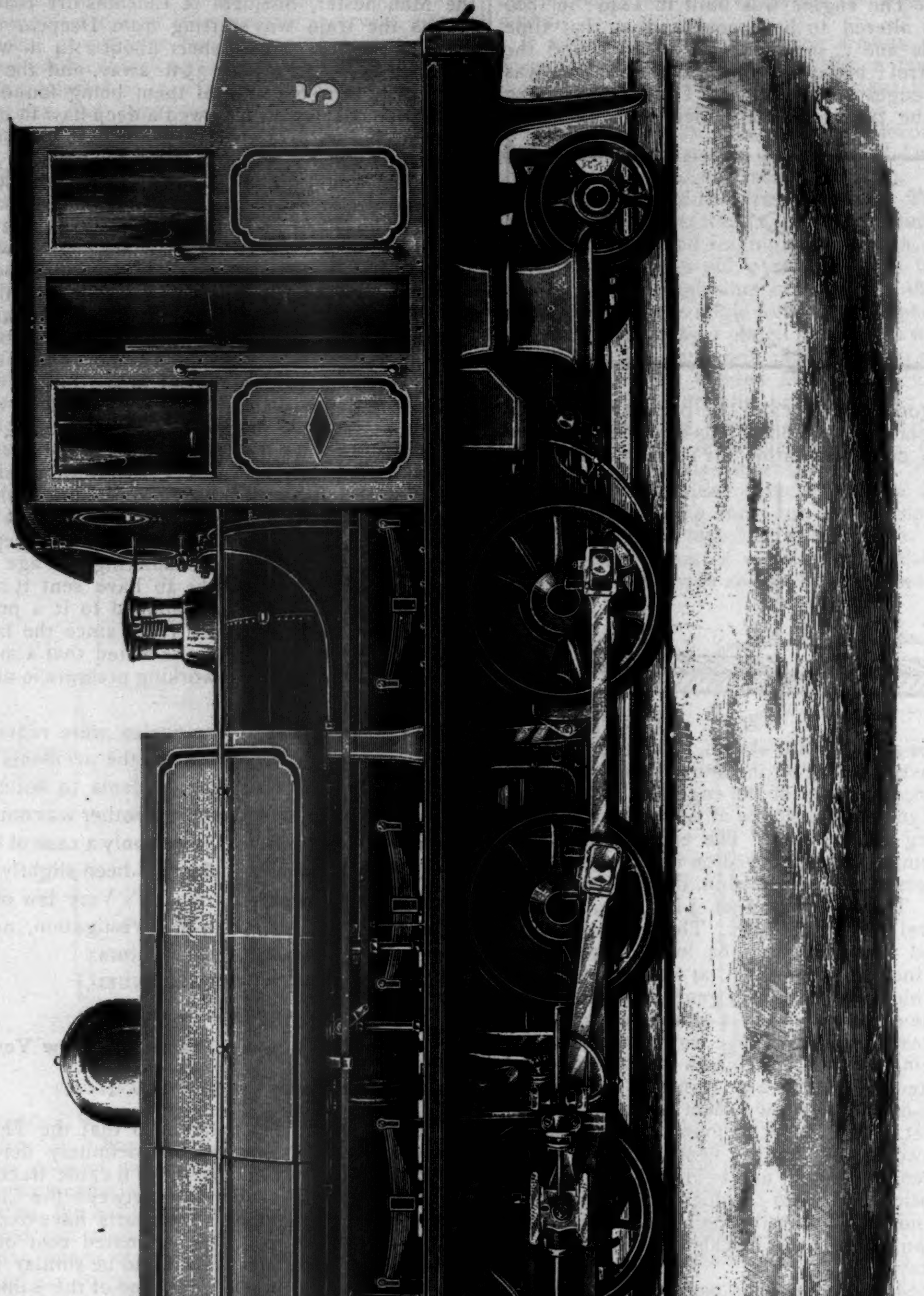
(TO BE CONTINUED.)

Street Railroad Traction in New York.

(From the *Electrical Engineer*.)

"IT is authoritatively announced that the Third Avenue Surface Railroad Company has definitely determined to commence the work of putting in a cable traction system, for operating its street-car line between the City Hall and Harlem Bridge, as soon as the courts have decided that it may lawfully do so. The estimated cost of the cable plant, which, we understand, is to be similar to that now in use upon the Tenth Avenue line of the same company, is stated to be $1,500,000.

This determination upon the part of the management of such an important street-rail line will doubtless cause some little surprise in electrical circles, especially in view of the rapid advance which has been made during the past year or two in the application of electricity to this class of traffic. Yet upon consideration, it is difficult to see how any other conclusion could have been reached, in view of the fact that it was apparently necessary that some decision should be reached at once. While no well-informed electrical engineer has any doubt that it is entirely feasible to construct and maintain an electric plant of the dimensions required in the present case for less than one-half the sum which will have to be expended upon the cable, yet, at present, it cannot be said that there exists a single electrical establishment in this country which could be depended upon to undertake the work of furnishing equipment for such a line as the Third Avenue, for a fixed sum and to be delivered within a fixed time, and to guarantee its successful and satisfactory operation. Hence it is not to be wondered at that the Third Avenue Company, having an enormous and practically constant traffic which has



TEN-WHEEL TANK LOCOMOTIVE FOR KAIPING RAILROAD IN CHINA.

BUILT BY DÜBS & COMPANY, GLASGOW, SCOTLAND.

outgrown its present facilities, and a line nearly eight miles in length, with almost no curvature—conditions most favorable for the economical application of cable traction—should prefer to adopt it, especially as responsible engineering firms stand ready at any moment to undertake the work.

Nevertheless, we venture the prediction that within five years the managers of the Third Avenue Company will have cause to regret the decision, which under existing circumstances it has practically been forced to make. It would hardly afford the Third Avenue people much gratification to see a parallel line doing the same or even better work with a plant whose first cost and operating expenses were not more than one-half that of their own. Yet the probability that this will come to pass within a very few years is so great that it practically amounts to a certainty. The notion which prevails in some quarters that electricity is less economical when employed on a large scale than on a small one, is an utter fallacy, and should not find credence for a moment among capable electricians. The cable-traction system in practice is a vast improvement over horse-power, a remarkable triumph of mechanical ingenuity and constructive ability; but it is not the final solution of the street-railroad problem, except under very special conditions, such, for example, as those which exist in San Francisco or Kansas City. As our English cousins would say, it is simply a question of *£ s. d.*, and from this point of view the ultimate result cannot be doubtful.

Locomotive for the Kaiping Railroad, China.

THE accompanying cut (from the London *Engineering*) is a general view of one of 10 small ten-wheel tank locomotives now under construction by Dübs & Co., in Glasgow, Scotland, to go to China. The general plan of the engine, with six driving wheels connected and a two-wheeled truck at each end, is shown by the engraving.

These engines, with one exception the first built for regular service in China, are to work on the railroad from the coal mines at Kaiping to the port of Pehtang, at the mouth of the Pei-Ho River. At first this line is to be used for coal exclusively, but it will probably be opened for general traffic later.

A French Criticism of the American System of Train Despatching.

M. ROEDERER, Engineer of Bridges and Roads, and Assistant Superintendent of the Paris, Lyons, & Mediterranean Railroad, who was one of the French railroad officers who last year visited the United States, contributes to the *Annales des Ponts et Chaussées* an article on the movement of trains on the railroads of the United States. This article gives a very fair description of the American system of train despatching, stating facts which are here sufficiently familiar, and closes with the following comments on the American system as compared with that in use in France:

Finally, what is this organization worth? The Americans are proud of it, and consider it the latest step of progress. It is very ingenious, very interesting, and very original. But it is, in my eyes, rather an expedient born of the particular needs of their management than a system to be recommended in itself.

It is necessary to remember that the traffic of the great lines varies enormously from one time to another; that they must constantly provide for conditions suddenly arising, and that, under these circumstances, the rules in force on the French railroad systems would, without doubt, be entirely insufficient. These rules are excellent for a regular traffic, varying but slightly from one season to another from a certain average; but they are less and less excellent as the number of irregular trains increases. If the number of special or wild trains should be increased until it is two or three times as great as that of the regular trains, who can say that our French station officers and trainmen, confused by a service so different from that to which they are accustomed, would not be exposed to serious complications and dangerous lapses of memory?

There is another consideration. Our French rules are not adapted to a train movement at all hurried. One has only to look at a train-sheet to see the gap which a fast train makes among the slower trains which should arrive at a station 15 or 20 minutes before it passes the same point. This effect, easily seen in theory, is still more marked in actual practice, and it is a common thing to see a train held for a long time at a station before it can resume its movement behind the train to which it gave way. As it is necessary to take account in a certain degree of these inevitable delays, the effective capacity of a line is more or less reduced by them.

In the American system it is not so; the despatcher holds all the trains in his hand, he is in constant communication with them, he can put them on a siding at the last moment, can hold them for the shortest period of time, and thus obtain the greatest possible movement.

But while this result is everywhere visible, it can especially be seen on the single-track lines, of which there are still many important ones in America. On such lines in France we could only send out a special train by the aid of a combination of notices which would require several hours' time; or if, in a case of extreme urgency, a train were run by telegraph, it could only move from station to station, stopping at each to get the track clear ahead of it. It would be the same in case of a change in the meeting places of regular trains, or in case a train should be started out of its turn. All this causes much loss of time and reduces largely the number of trains which we can move on a single track.

The American system escapes these inconveniences, and consequently permits of the most complete utilization of the track. Experience shows this fact; we travelled between Buffalo and Chicago on a single-track line 536 miles long, which at the busiest season has an average movement in each direction daily of 10 passenger trains of different speeds and of 30 freight trains, or a total of 80 trains; and there are days when this average is exceeded. On the single-track Pittsburgh, Cincinnati & St. Louis line (over which we did not travel) I am informed that the movement has sometimes reached 75 trains a day in each direction.

These are certainly brilliant results; but whatever American railroad officers may say of them, the system under which they have been attained is not one which could be recommended in France. They have sacrificed, I fear, to the imperious necessity of moving a large number of trains over lines hardly fitted for it, a necessity which we consider still more imperious—that of guarding by the most minute precautions the human lives confided to us. The impression which is forced upon me by this study is that the Americans are imprudent, and others will doubtless agree with me.

But this is only an impression; to decide impartially as to the value of the two systems of train movement, it is necessary to compare them by their results, and to find, by the aid of official figures, how many persons the American railroads and our own have killed and wounded for an equal number of passengers carried one kilometer (passenger-kilometers).

Unfortunately there are in the United States no official statistics on this point, and it is necessary to rely in these matters on a private publication, *Poor's Manual*. This work is very interesting, but its figures must be received with some caution, as they are based entirely on returns furnished voluntarily by the companies. If we consult these returns, in default of more reliable ones, we find that in 1885, on 201,370 kilometers of road then operated, there were 1,837 passengers killed or wounded by accidents to trains. The total number of passenger-kilometers (passengers carried one kilometer) was 15,600,000,000, which gives an average of a passenger killed or injured for each 8,500,000 passenger-kilometers.

On the Paris, Lyons & Mediterranean system the average of seven years, taken from the official statistics collected and published by the Ministry of Public Works, is one passenger killed or injured to each 36,000,000 passenger-kilometers.

Thus in the United States they kill or injure 4½ times as many people as we do in France.

When the very obliging and courteous travelling companions furnished us by the American railroad managements, to whom I am indebted for the information given in this note, were astonished at my want of enthusiasm over their system, it was by these figures that I answered them.

TRIPLE-EXPANSION ENGINES ON LAKE STEAMERS.

[Paper read before the Civil Engineers' Club of Cleveland by Walter Miller. From the Cleveland *Iron Trade Review*.]

THE past year may be regarded as a transition period in the history of the marine engine for lake service, as the high-pressure triple-expansion engine has now proved the successful rival of the compound engine. The object of this paper is to bring before you the result of what little experience the writer has had with this new type of engine, and to try to describe briefly the different designs brought out, as well as that which has a direct bearing on its efficiency.

Some two years ago the writer read a paper before this Club, entitled Compound Engines for Lake Service, and it was then stated that when the triple-expansion engine with its higher steam pressure came into use (as it was certain to do) it would be still more favorable to working steam expansively, and that instead of 10 or 12 expansions, we would have 18 or 20. Little was it expected at that time that less than one year from then the different engineering establishments of the lake marine would be actively engaged in building triple-expansions for the lake service. At the time that paper was read there were no triple-expansion engines being built in this country, and but very few in England and Scotland.

This fact is mentioned here to show that the engineers of the lake marine are awake to the importance of being well up to the times. The first triple-expansion engine was designed by Mr. Kirk at the engineering establishment of George Thompson & Company, near Glasgow, for the steamship *Aberdeen* some three or four years ago. Since then the triple-expansion engine in that country has almost superseded the double compound. In the annals of marine engineering there is no parallel to the rapidity with which these engines came into favor.

On the *Aberdeen* the saving in fuel per voyage was 500 tons, and her carrying capacity was increased by that amount. For ease of working, smooth running, and high piston speed they are not to be compared to any other class of engine built at the present time. It is only a question of time, and that very short, before the quadruple-expansion engine will supersede the triple-expansion engine for lake service.

We may look for high steam pressure and little or no cut-off, but simply expand from one cylinder to the other, with cylinder ratio proportionate to decrease of temperature and increase of volume, avoiding loss or condensation and evaporation. These days one hardly gets familiar with one particular type of engine before there is another brought forward; text-books become obsolete almost before they leave the printers' hands. Imagine, if you please, Bourne's rules for diameter of piston-rod—that is, one-sixth the diameter of cylinder equals diameter of piston-rod—to apply to size of piston-rods for a triple-expansion engine, with cylinder ratio of 2½ to 1. In fact, there are but very few rules to apply to the designing of modern marine engines.

The most important change brought about by the introduction of these engines has been in the valves and valve gear. The old complicated cut-off arrangement has given place to the most simple slide-valves and direct motion. With the high steam used, mainly 150 lbs. per square inch, all the parts of the valve gear must be well designed. Piston-valves are generally used on the high-pressure cylinders, single-ported slide-valve on the intermediate cylinder, and double-ported slide-valve on the low-pressure cylinder. Some designers think it imperative to use piston-valves on the high-pressure cylinders; and piston-valves have in some instances been used on all the cylinders. It has been found in practice, however, that with good hard iron in both cylinder and valve, slide-valves on the high-pressure cylinder work equally well and are very much cheaper and easier to repair.

Where piston-valves are used on all the cylinders the clearance spaces are excessive, and the steam passages are liable to be cramped, and further, where piston-valves are used throughout, two valves have to be used on the low-pressure cylinder, thereby complicating the valve motion. With the three-cylinder fore and-aft arrangement, it has been quite a problem to design a good valve gear, and has resulted in bringing forward a number of novel devices for reversing and driving the valves; those on the radial motion single eccentric being the more prominent, although the Joy valve and others of that class have been quite extensively used. The Joy valve gear and those of the radial motion single eccentric plan permit the cylinders to be placed fore and aft with steam-chests out in front, making a very convenient engine to get at. But the piston or some balance valve must be used, or else the wear will be excessive. The valve motion described above refers more particularly to those used by Scotch and English engineers, and on nearly all of those built on the coast. But with one exception the link motion has been used on the engines for lake service. The link when well proportioned and correctly suspended has proven the most satisfactory arrangement yet devised to drive the valves on marine engines up to the present time.

A well-known engineer on the coast after using a radial single eccentric motion on two engines declared himself still in favor of the links. It is the practice of the writer's firm, with but one exception, to place the three cylinders in line fore and aft, and slide-valves on all the cylinders (fig. 1); that of the high-pressure on the forward side, the

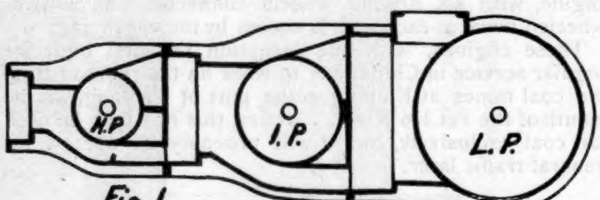


Fig. 1.

intermediate valve between the high-pressure and intermediate cylinders, and the low-pressure valve between the intermediate and low-pressure cylinders; single slide-valve on the high-pressure and intermediate cylinders and double-ported slides on the low-pressure, with link motion to drive all the valves. This arrangement of cylinders and valves admits of six journals in the bed-plate and crank-shaft in three duplicate interchangeable parts. Other builders, however, arrange the cylinders in two different ways: First, with three cylinders in line fore and aft with piston-valve on forward side of the high-pressure cylinder, single slide-valve on the forward side of the intermediate cylinder in separate steam-chest not connected to high-pressure cylinder, and double-ported slide-valve on after side of low-pressure cylinder with link motion to drive all the valves (fig. 2). This arrangement admits of five jour-

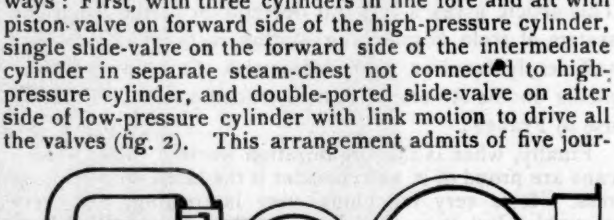


Fig. 2.

nals in the bed-plate and crank-shaft in one or two parts. Second, the three cylinders in line fore and aft; the intermediate cylinder placed forward, and slide-valve and steam-chest on forward side, the high-pressure in the middle, with piston-valve faced out in front and low-pres-

sure cylinder aft with double-ported slide-valve and steam-chest on the after side. The valves for the two outside cylinders—that is, the intermediate and low-pressure, are driven with the link motion and the high-pressure piston valve with Joy valve gear (fig. 3). This arrangement

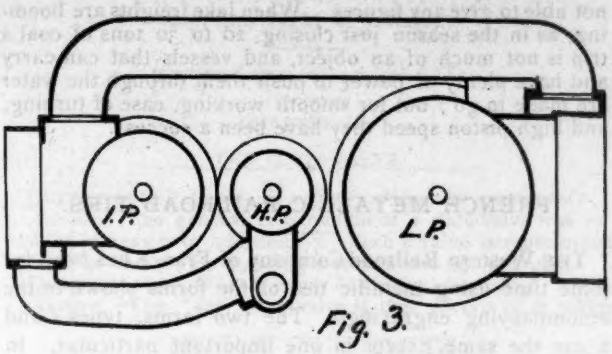


Fig. 3.

of cylinders admits of but four journals in the bed-plate and crank-shaft in one piece. The latter plan would seem the simplest and cheapest, but the design is open to three objections: First, there are two kinds of valve motions requiring two different motions to reverse, and this looks very unmechanical to say the least, although it works well in practice. The second objection is to the journals in the bed-plate, which are four in number, but are two different lengths and all subject to the same wear; therefore, the shortest one would wear down faster than the longer one; then again, the two middle journals, although they are the longest, are not long enough to fill between the cranks, leaving the crank-shaft unsupported close up behind the crank-arms; further, the crank-shaft is built up in one piece with the three throws requiring very careful work and difficult work to handle; besides, it would be very expensive to repair in case of a break-down. The third objection is to the manner of passing the steam from one cylinder to the other. With the high-pressure cylinder in the middle the steam is exhausted from it to the intermediate cylinder on the forward side and exhausted from it to the low-pressure cylinder, which is on the after side of the engine. This arrangement, although it works well, is like placing an engine away from the boiler and supplying it with steam through a long steam-pipe. The second plan mentioned above is that with a high-pressure cylinder placed forward and piston-valves on forward side, the intermediate cylinder in the middle and that of the low-pressure aft, with the valve of the intermediate cylinder placed forward in a separate steam-chest; between it and the high-pressure cylinder also the valve of the low-pressure cylinder on the after side and five journals in the bed-plate with crank-shaft in two parts. This plan costs more than the one with four journals in bed-plate, but is open to about the same objection.

There is an unsightly array of pipes to convey the steam from one cylinder to the other, and on some engines built on this plan the arrangement of journals in bed-plate is very bad. Some of the journals are extremely short, while the journal adjacent to it is more than double the length, making it impossible for them to wear down equally. The shaft, although it is made in two parts, is not in duplicate, consequently is not interchangeable. Shafts thus made have no possible advantage except to facilitate somewhat the building and repairs. Engines built on the first-mentioned plan—that is, with the three cylinders in line fore and aft, with high-pressure forward, the steam-chest on forward side, and the intermediate in the middle, with valve placed on the forward side in a separate steam-chest, formed by bolting the high-pressure and intermediate cylinders together, the low-pressure placed aft and the valve on the forward side in a steam-chest formed by bolting the intermediate and low-pressure together, although the most expensive are on by far the more mechanical plan and conducive to the best economy. The exhaust is conveyed from one cylinder to that of its fellow in the shortest possible manner by an exhaust belt cast on the side of cylinder almost in a straight line; and when lagged up it has a symmetrical look about it that is not seen in any of the other designs. Access is had to the valves by covers placed on top of the steam-chest. As mentioned before, there are six journals in the bed-plate, all of equal length, and all things being equal, should wear down alike. The crank is in three duplicate interchangeable parts, therefore making a very simple crank to build and repair. With this same arrangement of journals and crank-shafts the valve gear is brought in line with the valves without any off-sets or bent eccentric rods. What would have been a very pleasing design to the eye many times has been marred by a bent eccentric rod, aside from the mischievous way they have of dodging their work.

There is another design of triple-expansion engine that is considered the simplest and cheapest to build, but does not seem to take as well—that is, those that have two cylinders in line fore and aft, the intermediate and low-pressure, with the high-pressure placed on top of the intermediate cylinder (fig. 4). The principal objection to this

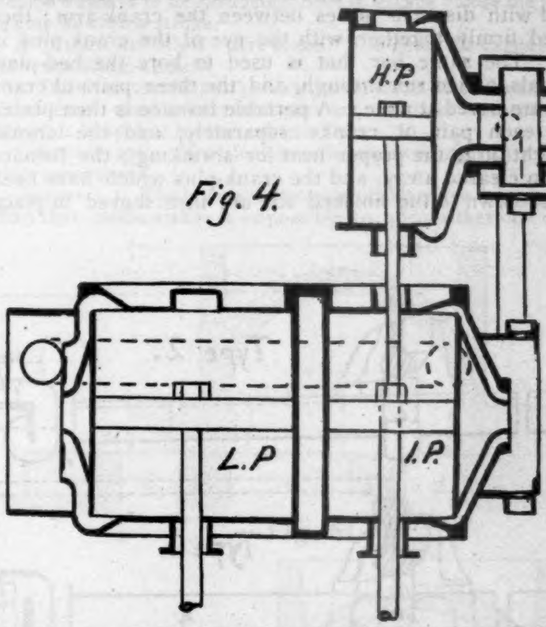


Fig. 4.

plan is that it throws too much work on one crank-pin, making a very unequal strain on the crank-shaft, and, you may say, all of the other working parts of the engine. There has been to the writer's knowledge but one engine built on this plan for the lake service. Although it worked well and gave every satisfaction, it did not seem to attract the attention that the others did built on the three-cylinder, fore-and-aft plan.

Since the triple-expansion engine came out it has been the aim of designers to so proportion the cylinders that the work done in one will be about equal in each, thus equalizing the fall of temperature. In some cases the H.P. developed would not vary more than 3 to 5 in each cylinder, but this equalizing of power has been assisted by the sliding blocks in the reverse arm lengthening out or shortening the valve travel. It would seem the better way to so proportion the cylinder valves and size of receiver space that the work done in each cylinder would be equal, and by notching up with the reverse gear vary the range of expansion rather than trust the engineer to adjust the valve travel to equalize the work done in each cylinder. The exact ratio of cylinder is not an arbitrary matter requiring deep mathematical study. The distance from center to center, arrangement of valves, steam-chest, and receiver spaces, as well as crank sequence, should be taken into account, as they affect the cylinder ratio very materially. Too large receiver space between cylinders would result in fall of pressure and lower temperature. Crank sequence or order of following is best arranged by taking into account the arrangement of cylinders.

The writer's experience so far has been with the low-pressure leading, intermediate following, and the high-pressure last; but with the present plan of cylinders—as the receiver spaces are rather large—it would be better i

the high-pressure crank was leading, intermediate following, and low-pressure last. With the former order of following, the back pressure would be through one-sixth of the revolution, while the latter order following the back pressure would be through one-third of the revolution; the increase of back pressure in this case would result in bringing up the initial pressure and equalizing the work done in the after cylinder.

The three-throw crank-shaft for the triple-expansion engines built by the writer's firm is of the built-up class, and requires very careful and accurate work in boring, fitting, and shrinking to insure its alignment when bolted together in place. The bed-plate is first fitted with the six pairs of journal brasses and a large boring-bar is run through, and all of the six journals are bored out at once; then a truing mandril is used to scrape the journals down to a bearing. The six pieces of shafts with couplings forged on all turned down to size, and the crank-arms shrunk on and keyed, are then placed in the bearings and fitted with distance pieces between the crank-arm; then bolted firmly together, with the eye of the crank-pins in line. The same bar that is used to bore the bed-plate journals is then run through, and the three pairs of crank eyes are bored at once. A portable furnace is then placed over each pair of cranks separately, and the cranks brought up to the proper heat for shrinking; the furnace is then cleared away, and the crank-pins which have been turned down to the finished size are then shoved in place and left to cool. Each part of the crank-shaft is then put in the lathe and about $\frac{1}{64}$ in. turned off the journals, and the couplings faced up. The holes for the coupling bolts are drilled by templet, and the bolt-holes are reamed after the cranks are in place. Each part of the crank is in duplicate and will interchange, thus lessening the delay in case of a broken crank.

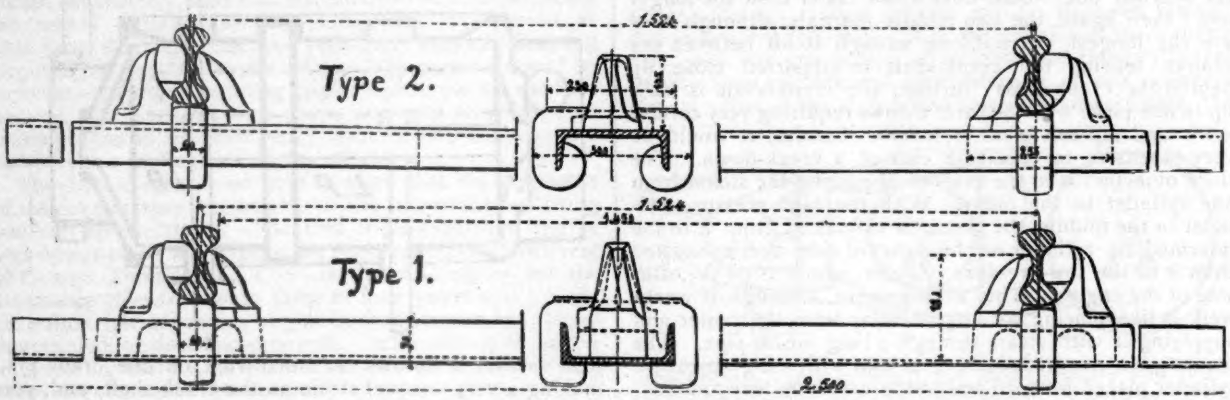
The increased steam pressure carried with the new engines has resulted in the abandonment of the old return tubular fire-box boiler, so long in vogue for the lake service. With such large crown sheets and flat-stayed surfaces, it was impracticable to continue their use, and led to the adoption of the boiler which is commonly called the Scotch boiler, with circular furnaces and return tubes. The furnaces are either corrugated or else flanged in short lengths with rings between the flanges. Boilers on this plan are now being made for the lake service 14 ft. in diameter by 12 ft. long, with steel shell plates $1\frac{5}{32}$ in. thick, to carry 160 lbs. of steam per square inch. The shell plates are all drilled and double-riveted by hydraulic riveters, as it would be almost impossible to make these boilers tight by hand riveting. Heavy machinery for riveting, bending, flanging, and drilling these plates for the building of these boilers has had to be added to the boiler-building plants on a scale little thought of two years ago.

As yet nothing has been mentioned as regards the economy of the triple-expansion engine for lake service. As was intimated at the beginning of this paper, the writer had been waiting for some data to compare with the compound engine, and therefore can only say that they have shown a very marked economy; but as to how much he is not able to give any figures. When lake freights are booming, as in the season just closing, 20 to 30 tons of coal a trip is not much of an object, and vessels that can carry and have plenty of power to push them through the water are made to go; but for smooth working, ease of turning, and high piston speed they have been a success.

FRENCH METALLIC RAILROAD TIES.

THE Western Railroad Company of France has been for some time using metallic ties of the forms shown in the accompanying engravings. The two forms, types 1 and 2, are the same, except in one important particular. In type 1 the channel-bar, which forms the greater part of the tie, has its flat side down, while in type 2 the flat side is up, the angles of the channel-bar entering the ballast. The results are given as follows by M. Jules Morandiere, Engineer of Material for the Company:

Experience with the two types of ties shown has proved that the tie of type 1 should be used, because it beds itself well in the ballast, and because it is, in relation to stability, under the same conditions as a wooden tie.



METALLIC TIES USED ON WESTERN RAILROAD OF FRANCE.

(*Dimensions in meters and millimeters.*)

The tie (type 1) consists of an iron channel-bar placed with the flat side down, upon which the chairs are *cast*; these chairs being of such a form that only one key is required. The weight of the tie is about 286 lbs., the iron tie proper weighing 163 lbs., and the castings 123 lbs.

The perfect welding of the castings to the iron channel-bar can be obtained in several ways. M. Chassée, who made the first ties in his factory at Mans, has taken a patent for the method which he uses.

The chairs shown in both types are designed for a double-head rail. No special design has yet been made for a tie to suit rails of the Vignoles pattern, although the company has about 1,180 miles of track with rails of that pattern. But in the opinion of this company the use of a chair interposed between the rail and the tie is necessary for the Vignoles as well as for the double-head rail on all lines where there are sharp curves or many grades. Already chairs have been put under about 249 miles of its line where the Vignoles rail is used. Under these conditions the metallic tie, if used with that type of rail, would differ from type 1, as here shown, only by a slight change in the form of the chair.

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

BY M. N. FORNEY.

(Continued from page 576, Vol. LXI.)

CHAPTER VI.

THE SLIDE-VALVE.

QUESTION 102. *How is an ordinary slide-valve constructed?*

Answer. The general construction of a slide-valve was explained in answer to question 67. Such a valve is represented by figs. 49 and 50, fig. 49 being a section and fig. 50 a plan.

QUESTION 103. *What is meant by the lap of a valve?*

Answer. The "*lap*" of a valve is that portion of it which

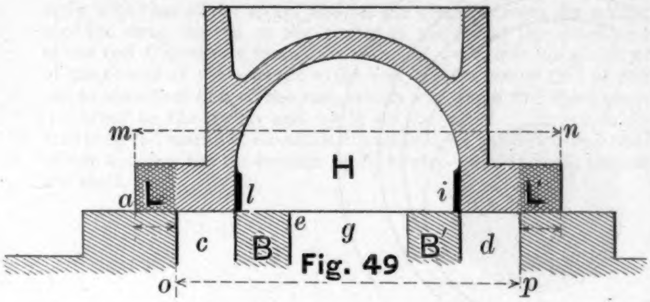


Fig. 49

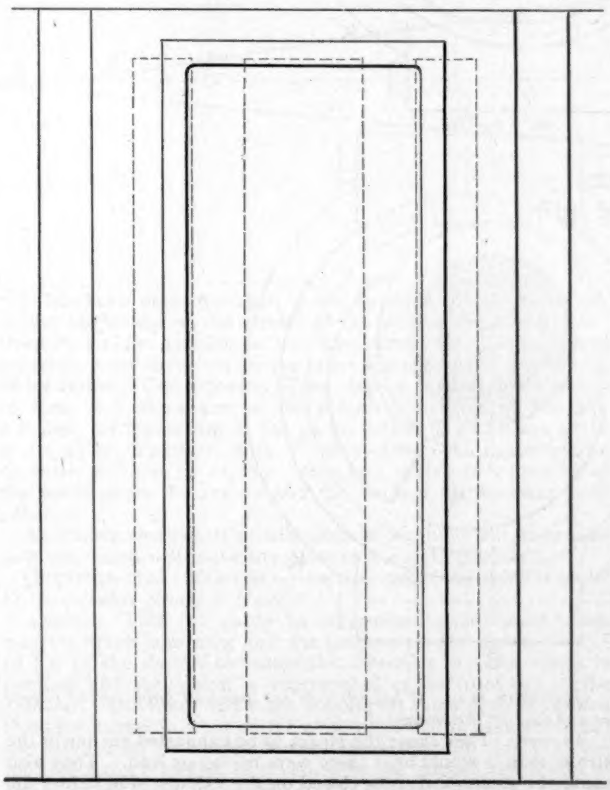


Fig. 50

overlaps the steam-ports, when it stands midway over the valve-face. Thus in fig. 49 the parts *L L'*, shaded with cross lines, and which overlap the outside edges of the steam-ports *c* and *d*, form the "*outside lap*" of the valve; and the parts *l l'*, shown in black, which overlap the inside edges of the steam-ports, form the "*inside lap.*" Ordinarily in speaking of the "lap" of a valve it means the outside lap.

QUESTION 104. *What is meant by the "lead" of a valve?*

Answer. "*Lead*" means the width of the opening of the steam-port when the piston is at the beginning of its stroke. Thus if the valve *H*, fig. 51, stood in the position shown, when the piston is at the end of the cylinder, and the piston is at the beginning of its stroke, the opening *a* of the steam-port *c* would be the lead. The opening of the port on the outside of the valve is called *outside lead;* on the inner or exhaust side, as shown at *b*, it is called *inside lead.*

QUESTION 105. *What is meant by the "travel" of a valve?*

Answer. By the "*travel*" we mean the distance that the valve is moved back and forth, or, in other words, its stroke. In an engine like that shown in Plate I, if the rocker arms are both of the same length, the travel of the valve will be equal to the throw of the eccentric.

QUESTION 106. *What are the essential conditions which a slide-valve must fulfil in governing the admission and exhaust of steam to and from the cylinder of an ordinary engine?*

Answer. 1. It must admit steam to one end only of the cylinder at one time, so that the pressure, which moves the piston, will not be exerted on both sides of it at the same time.

2. It must cover the steam-ports so as not to permit steam to escape from both steam-ports at once.

3. It must allow the steam to escape from one end of the cylinder *before* it is admitted to the other end, so as to give the steam, which is to be exhausted, time to escape before the piston begins its return stroke.

4. It must not allow "live steam" * to enter the exhaust-port from the steam-chest.

5. In order to utilize the expansive force of the steam, the valve must close each steam-port on the outer or steam side before it is opened on the exhaust side.

QUESTION 107. *How does the valve shown by figs. 49–51 fulfil these conditions?*

Answer. 1. The lap on the outside of this valve being greater than that inside makes it impossible to open either one of the

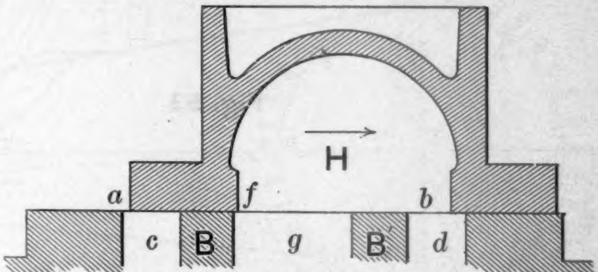


Fig. 51

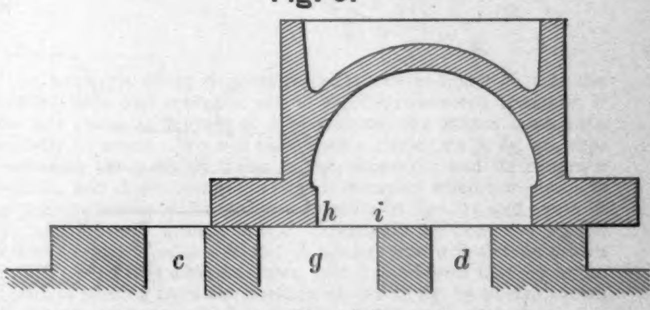


Fig. 52

steam-ports for the admission of steam, until *after* the other port is opened to the exhaust. Thus the valve cannot be moved from the position shown in fig. 49 to that shown in fig. 51, so as to open the port *c* at *a*, without first opening the port *d* at *b*, which allows the steam in *d* to escape into *g*. The outside width of the valve, as indicated by the dotted line *m n*, fig. 49, is greater than the distance over the outside edges of the steam-ports—shown by the dotted line *o p*—so that it is manifestly impossible for the valve to uncover both steam-ports, and thus admit steam into each at once.

2. The width of the exhaust cavity *H* in the valve, measured from *l* to *l'*, is less than the distance over the inner edges of the steam-ports *c* and *d*—consequently, these ports cannot both communicate with the exhaust cavity simultaneously.

3. If the valve shown in fig. 51 is moving in the direction indicated by the dart at *H*, it is obvious that the steam-port *d* will be opened to the exhaust at *b* before the port *c* will be uncovered at *a* for the admission of steam. The same action will occur when the valve moves in the opposite direction, and, as already pointed out, is due to the fact that the outside lap is greater than that inside.

* By *live steam* is meant steam which has been taken direct from the boiler, and which has not been expanded in the cylinder. The term is used in contradistinction to steam which has been admitted to the cylinder, and by the exertion of its expansive force has done work on the piston.

4. Live steam cannot enter the exhaust-port unless it should be uncovered by the valve. This cannot occur unless the valve, fig. 49, should move far enough so that its edge *a* will pass beyond the edge *e* of the exhaust-port. For this reason half the travel of the valve must always be less than the widths of the lap *L*, the steam-port *c*, and the bridge *B* * added together.

5. It will be plain that if the valve shown in fig. 51 is moving from right to left, or in the reverse direction to that indicated by the dart *H*, that the opening *a* will be closed before the port *c* is opened on the exhaust side, as the width *a f* of the valve is greater than the width of the steam-port.

QUESTION 108. *What other point must be observed in proportioning a slide-valve and the steam-ports for it?*

Answer. The exhaust-port must be made of such a width that when the valve is at the end of its travel the opening of the port will be wide enough so as not to choke or "*throttle*" the exhaust steam. Thus in fig. 52 the valve is represented in the position it occupies at one end of its travel. The point which must be observed is, that when it is in this position the opening *h i* must be sufficiently wide for the free escape of steam from the port *d*.

QUESTION 109. *How does the lap of a valve cause the steam to act expansively?*

Answer. When a valve has an outside lap, as was explained in answer to question 80, those portions of its face which cover the steam-ports, being wider than the ports, occupy some time in moving over them, during which time the steam is enclosed in the cylinder, as there is then no communication either with the steam-chest or the exhaust-port. This action of the valve is due to its lap.

QUESTION 110. *What other good effect results from the outside lap of a slide-valve?*

Answer. If the outside lap of a valve is greater than that inside—as it always is in well-proportioned slide-valves—it causes the exhaust-port at one end of the cylinder to be opened before the steam-port at the other end is uncovered to admit steam. This is shown in fig. 35, from which it will be seen that if the valve is moved in either direction one of the steam-ports will always be opened on the exhaust side of the valve before it is opened to admit steam to the cylinder.

QUESTION 111. *What is the object in giving a slide-valve lead?*

Answer. It is done so that the steam-port will be opened for the admission of steam a little before the piston reaches the end of its stroke, so that there will be a cushion of steam to receive the piston and reverse its motion at the end of the stroke. Another advantage which lead gives is that it results in the steam-port being wider open when the piston begins its return stroke than it would be if there were no lead.

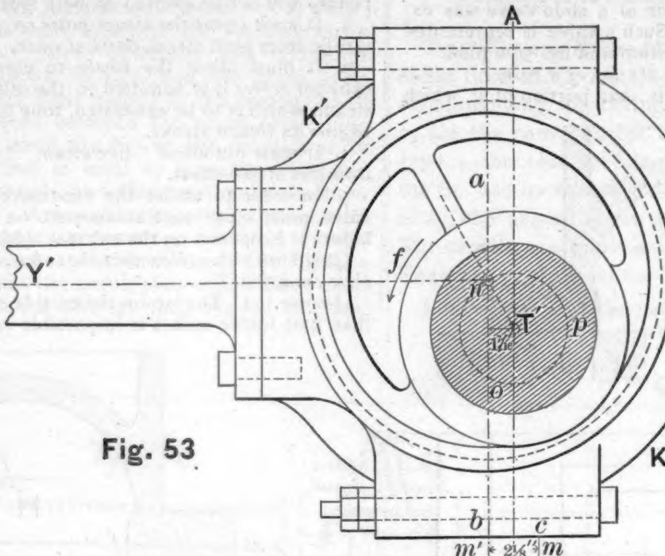


Fig. 53

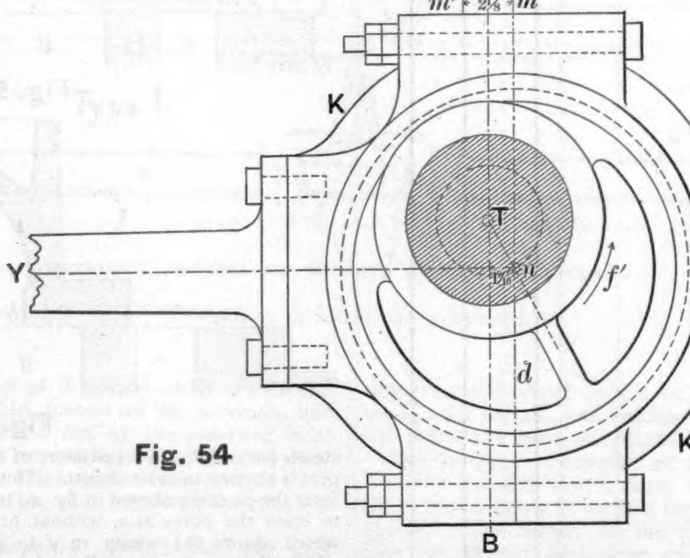


Fig. 54

QUESTION 112. *What effect do lap and lead have on the release or exhaust of the steam?*

Answer. They cause the steam to be exhausted earlier in the stroke than it would be if there were no lap or lead. They also cause the steam-port to be closed on the exhaust side before the piston completes its stroke, the advantage of which will be explained hereafter.

QUESTION 113. *How is the motion imparted to a slide-valve which will make it fulfil the conditions which have been explained?*

Answer. In the answers to questions 68, 69, and 70 the general construction and action of an eccentric was described, but to make these still plainer, figs. 53 and 54 have been drawn showing an eccentric in two opposite positions, or as it would appear before and after the shaft has made half of a revolution.* In fig. 53 it is represented in the same position that it

* The metal *B*, between the steam and exhaust-port, is called a *bridge*.

* Figs. 53 and 54 are drawn to a scale just one half that of figs. 49 to 52—that is, figs. 49 to 52 show the valve one quarter its full size, whereas the eccentric is represented only one eighth of its full size.

occupies in fig. 15—when the piston is at the beginning of its stroke, and the valve is in the position shown in fig. 51, and has $\frac{3}{16}$ in. lead at *a*. In fig. 49 the valve is shown in the middle of the valve-face, and, as already explained, in fig. 51 it has moved from its middle position a distance equal to the lap $\frac{7}{8}$ in. and lead $\frac{3}{16}$ in., or $\frac{7}{8}+\frac{3}{16}=1\frac{1}{16}$ in. Consequently when the piston is at the beginning of its stroke and the valve is in the position described and shown in fig. 15, the eccentric must be in a corresponding position—that is, it must be $1\frac{1}{16}$ in. from the middle of its throw. In figs. 53 and 54 *T'* and *T* are the centers of the shafts, *A B* is a vertical center line drawn through these centers, and *n'* and *n* are the centers of the eccentrics. The valve, it will be seen from figs. 15 and 51, is on the *right* side of its middle position, therefore, as the motion of the eccentric is reversed by the rocker, the center of the eccentric must be on the *left* side of the middle of its throw. As the center *n'* of the eccentric revolves around *T'*, the center of the shaft, obviously *n'* moves an equal distance on each side of the vertical line *A B*. It has been explained in another place that the eccentric and its strap *K' K'* are always turned so as to fit each other accurately. Consequently, the center *n'* of the eccentric always coincides exactly with that of the strap, and, as the distance from the center *n* of the strap, fig. 14, to the center of the pin at the other end of the rod *L* always remains the same, if we know the position of the center of the eccentric, we can always know that of the pin at the other end of the rod, which will show the movement imparted to the rocker and by it to the valve. Therefore, in studying the action of an eccentric all that we need concern ourselves about is the movement of its center in relation to that of the shaft.

It has been explained that, in the example given, the valve, at the beginning of the stroke of the piston, must be $1\frac{1}{16}$ in. from its middle position on the valve-face. The center of the eccentric must therefore be the same distance from the middle of its throw. Consequently, if we draw a vertical line *a b*, $1\frac{1}{16}$ in. from *A B*, the center of the eccentric must be on the line *a b*, and, as the eccentric has $4\frac{1}{2}$ in. throw, if we draw a circle *n' o p*, $4\frac{1}{2}$ in. diameter, with *T'* as a center, the center of the eccentric will also be on this circle, and therefore it must be at the point where the line *a b* and the circle *n' o p* intersect each other.

As *a b* has two points of intersection, *n'* and *o*, we must take that one which will move the valve in the right direction.

QUESTION 114. *How can we know in which position the center of the eccentric should be placed?*

Answer. This can easily be determined if we know which way the crank is turning and the position of the piston. Thus in fig. 15 the dart *N* indicates the direction that the crank is turning, and the piston is represented at the front end of the cylinder. Obviously the front steam-port must then be opened to admit steam in front of the piston to force it backward, and the valve must be moved toward the right-hand side. As the motion of the eccentric is reversed by the rocker, the center of the eccentric must move toward the left-hand side. In fig. 53 the dart *f* shows the direction of revolution of the shaft—the same as *N* in fig. 15. It will be evident from the engraving that if the center of the eccentric is located at *n'*, that it will move toward the left-hand side, whereas if it was at *o* it would move toward the right-hand side when the shaft turns in the direction shown by the arrow *f*.

QUESTION 115. *What does fig. 54 show?*

Answer. In fig. 54 the shaft and eccentric are represented as having made a half revolution from the position shown in fig. 53. Consequently the center *n* is on the right-hand side of the line *A B*, and as far from it as it was in fig. 53.

QUESTION 116. *How can the action of an eccentric be shown in the most simple way?*

Answer. As explained in answer to question 113, the movement of the center of an eccentric shows the motion imparted to the strap and rod. All that is needed, therefore, is to draw circles which will represent the path in which the center of the eccentric revolves, and then lay out the position on these circles that the center would occupy during a whole revolution of the crank. But before describing how this is done, it will be necessary to give an answer to the following question:

QUESTION 117. *How can the position of the crank and eccentric be determined for any position of the piston?*

Answer. This can be done by the aid of the diagram fig. 55. Before describing the method of doing this, it should be explained first that the cross-head and piston, being rigidly connected together, their motion coincides exactly. We may therefore disregard the piston for the present, and simply observe the movement of the pin on the cross-head in relation to the crank. The large circle shown by a full line in fig. 55 represents the path of the center of the crank-pin, and is divided into degrees. The small circles 0, 4, 8, 12, 16, 20, and 24, on the left-hand side, represent the successive positions of the cross-head pin corresponding to those shown in figs. 15 to 21. The length of the connecting rod, 7 ft., is the distance from 0 to *a*, or from 12 to the center *T*. By taking this length in a pair of dividers, and with 4 as a center, if we intersect the circle with a small arc at *b*, it will give the position of the crank-pin when the piston has moved a distance equal to that from 0 to 4, or 4 in. of the stroke. With a connecting-rod of the length given, 7 ft., and 24 in. stroke of piston, it will be found that while the latter has moved 4 in. the crank has turned through 45 degrees of a complete revolution. In other words, a line *b T*, drawn through the center *b* of the crank-pin, and the center *T* of the shaft, will

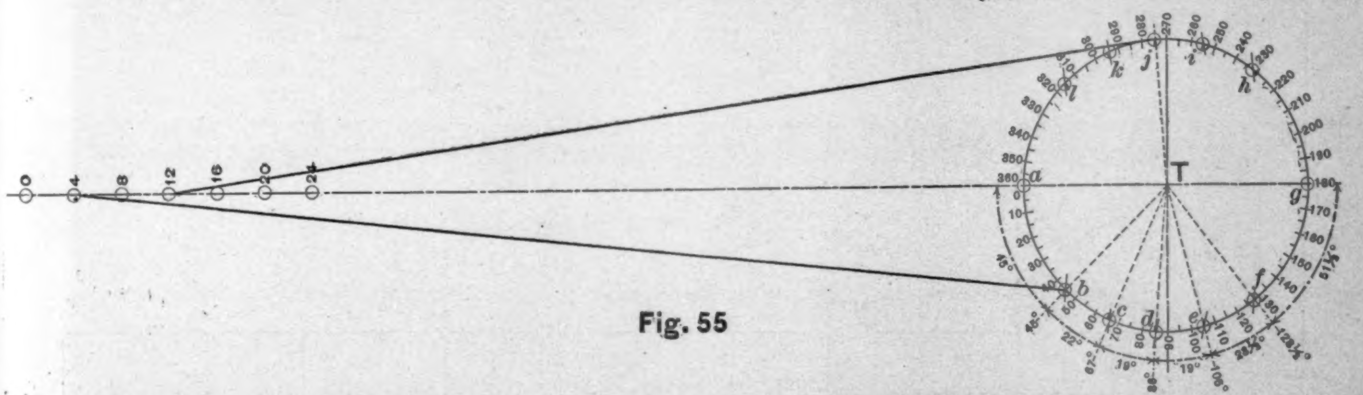


Fig. 55

form an angle of 45 degrees with the center-line *a T*. As the crank, shaft, and eccentric are all rigidly connected together, if the one turns 45 degrees of a revolution, the others must turn equally as much. We will now draw a circle, *n o p*, fig. 56, representing the path or throw of the eccentric, and its center *n* will be laid down in the position it occupies when the piston is at the beginning of its stroke, as shown in figs. 15 and again in 53, and we will draw a line *a T* through the center *n* of the eccentric and *T* of the shaft. A similar line will also be drawn in fig. 57. From what has been said it is obvious that while the crank is turning from the position shown in fig. 15 to that shown in fig. 16, or from *a* to *b* in fig. 55=45 degrees, that the eccentric must also have turned an equal amount. Therefore, if from the line *a T* in fig. 57 we lay off an angle *a T b*, = 45° the intersection of the line *b T* with the circle will represent the position of the center of the eccentric when the piston has moved 4 in., or is in the position shown in fig. 16, and the crank is in the position shown at *b* in fig. 55.

Returning again to fig. 55, let it be supposed that the piston has moved 8 in. We will take the center of the small circle 8 as a center and the length of the connecting-rod as a radius, and intersect the large circle with a small arc at *c*. It will then be found that in moving from *a* to *b* that the crank has turned 22 degrees. Proceeding as before, the line *b T* will be laid down in fig. 58 in the same position as in fig. 57, and an angle *b T c*, equal to 22 degrees, will be laid off from *b T*. Then the intersection of *c T* with the circle at *n* will be the position of the center of the eccentric when the piston has moved 8 in. of its stroke.

In this way we may proceed and lay out the position of the eccentric for each position of the piston shown in figs. 15–22, or for the corresponding position of the crank represented by *a, b, c, d, e, f, g, h, i, j, k,* and *l* in fig. 55. This has been done in figs. 56 to 69, and if the reader will draw a similar series of diagrams it will probably give him a clearer idea of the action of an eccentric than he can get in any other way.*

* In drawing such a series of diagrams, it will be best to make them to a larger scale than they are represented in the engravings.

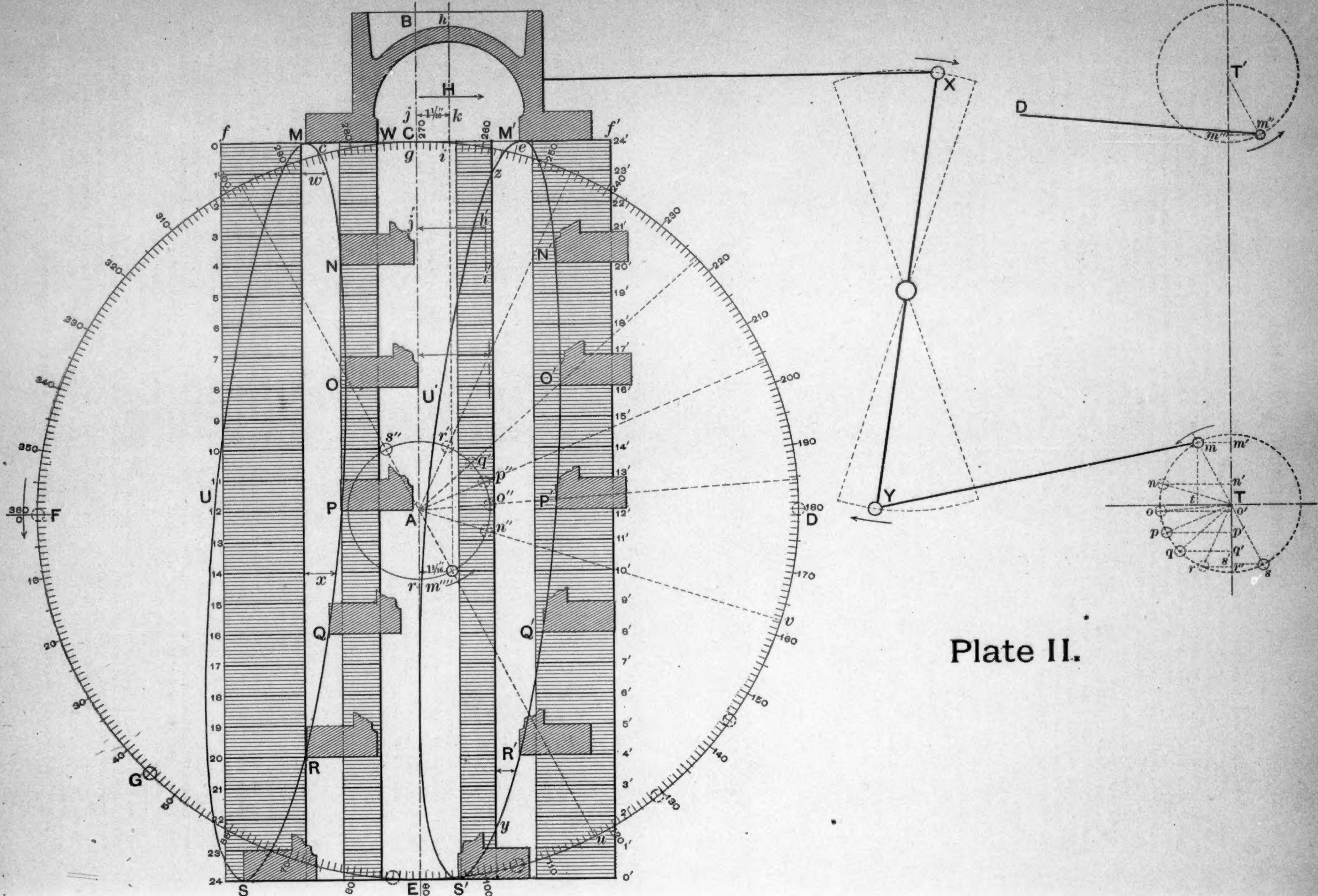
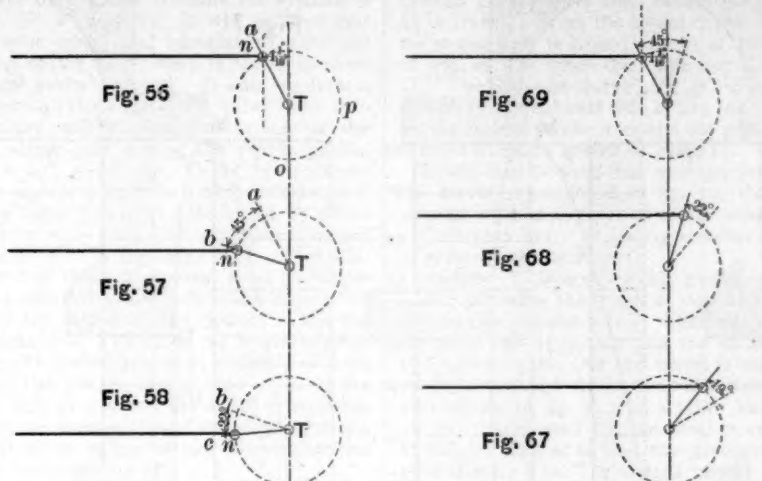


Plate II.

QUESTION 118. *How can the movement and the action of a valve be shown most perfectly on paper?*

Answer. By drawing a diagram—that is, by representing the valve in a number of the positions it occupies in relation to the steam-ports during a complete stroke of the piston, and then drawing what are called *motion curves* through the inner and outer edges of the valve in each one of the positions in which it is represented. As such curves are in a sense purely imaginary, and do not represent any object on an engine, it is difficult to explain clearly their nature and purpose, and perhaps still harder for those with little or no knowledge of drawing to understand an explanation, no matter how clearly it may be written. The reader must, therefore, expect to give close attention and perhaps some hard study to the following description of this method of showing the movement of a slide-valve, in relation to that of the piston and crank, and to the steam and exhaust-ports:



It will be supposed, in the first place, that the horizontal line *f f'*, Plate II, represents the valve-face, and *H* a valve with $\frac{7}{8}$ in. outside lap. *c* and *e* are the steam-ports $1\frac{1}{4}$ in. wide, and *g* the exhaust-port $2\frac{1}{2}$ in. wide, the bridges between being $1\frac{1}{4}$ in. thick. The valve *H* is represented in the position it would occupy when the piston is at the front end of the cylinder, and at the beginning of its stroke, the valve having $\frac{3}{16}$ in. lead at *M*. *B E* is a vertical center line through the valve-face and exhaust-port *g*. *h i* is the vertical center line of the valve. As the lap is $\frac{7}{8}$ and the lead $\frac{3}{16}$, the distance *j k* between the center line of the valve and that of the face must be $\frac{7}{8}+\frac{3}{16}=1\frac{1}{16}$ in.* Let *X Y* represent a rocker, *T* the center of the main shaft, and the dotted circle around it the path of the center *m* of the eccentric, which has $4\frac{1}{2}$ in. throw. The rocker and eccentric, to save room in the engraving, are both represented nearer to the valve-face than they would be on an engine. The position of the piston, crank, etc., are supposed to be the same as shown in fig. 15. The dart *H* shows the direction in which the valve is moving, and the one at *m* the way the eccentric is revolving. As the valve should be $1\frac{1}{16}$ in. from its central position at the beginning of the stroke, and the rocker-arms being of equal length, obviously the center *m* of the eccentric must also have moved the same distance, *m m'*, from the vertical line *m' r'* drawn through the center of the shaft. Therefore, if we draw a vertical line *m t* parallel with *m' r'* and $1\frac{1}{16}$ in. from it, as already explained, its intersection *m* with the dotted circle will be the location of the center of the eccentric, when the piston is at the beginning of the backward stroke, and the valve is in the position shown at *H*.

It will now be supposed that the piston has moved 4 in., or into the position shown by fig. 16. In doing so it will be seen that the crank has turned a certain distance from the dead point shown in fig. 15 to the position represented in fig. 16. It has been explained that this angle—with a connecting-rod and stroke of piston of the dimensions given—will be 45 degrees. Therefore, if we draw a line, *m T*, through the center of the eccentric and the center of the shaft, and draw another line, *n T*, through *T*, and at an angle of 45 degrees to *m T*, its intersection, *n*, with the dotted circle will represent the position of the center of the eccentric, when the piston has moved 4 in. from the dead point.

The effect of this movement on the valve can easily be fol-

* The reader is recommended to lay out the steam-ports on a strip of cardboard or wood, and the valve on another, full size. By sliding the valve on the valve-face, as described herein, he will be able to understand the description better than he can without such an illustration before him.

lowed if the reader will observe the direction of the motion indicated by the darts at *m*, *Y*, *X*, and *H*. It will be noticed that when the center of the eccentric is at *n*, its distance *n n'* from the vertical center line is greater than when it was at *m*. The horizontal line *m m'* is equal to the distance $j\,k = 1\frac{1}{16}$ in. between the center line of the valve and that of the valve-face. *n n'* shows the distance between these center lines when the piston has moved 4 in. of its stroke. If, therefore, we draw the valve, with its center-line, a distance equal to *n n'* from the middle of the valve-face, it will be in the position it occupies when the piston is in the position shown in fig. 16. If we drew it in this position on the line *f f'*, the drawing would be liable to be confused with the valve already represented there. To avoid such confusion another line 4 20' has been drawn a distance equal to the movement of the piston, 4 in., below *f f'*, and on this line a perpendicular *h' i'* has been laid down at a distance *j h'*, equal to *n n'* from the center of the valve-face. *h' i* will then represent the center of the valve in its new position. The edges of the ports *c g* and *e* have been extended downward, and the lower part of the valve has been drawn on the line 4 20',* with *h' i'* as its center, which shows it in the position it will occupy in relation to the steam and exhaust-ports when the piston has moved 4 in. of its stroke, as shown in fig. 16.

We can now proceed in the same way to show the position of the valve on the line 8 16' when the piston has moved 8 in. of its stroke, as represented in fig. 17. It has been shown from fig. 55 that when the cross-head pin has moved 8 in., that the crank has turned through 22 degrees of a revolution from *b*, or 67 degrees from the dead point *a*. If, then, we draw a line *o T* on Plate II at an angle of 67 degrees with *m T*, its intersection with the dotted circle will be the position of the center of the eccentric when the piston is in its new position. The center of the eccentric is therefore a distance *o o'* from the center line *m' r'*, which indicates the movement of the valve. For the reason already explained—that is, to avoid confusion in the

Fig. 70

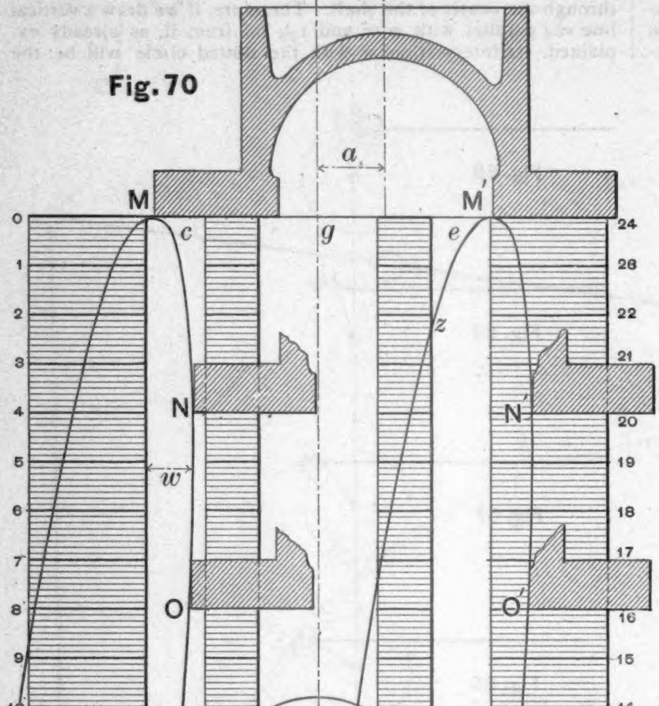
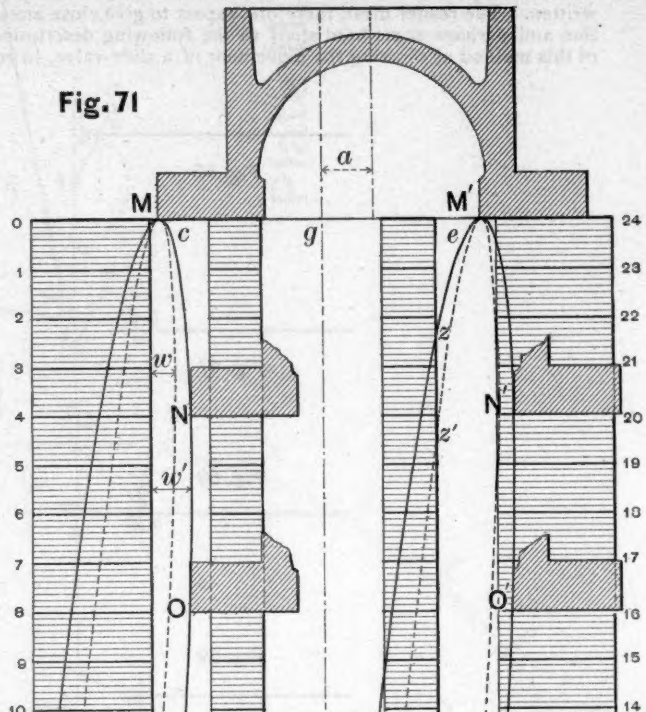


Fig. 71



* To avoid too much confusion, in the diagram only the edges of the valve, which control the admission and exhaust of steam, are represented in its successive positions.

diagram, the valve will be represented in its third position on the line 8 16', and it will be laid off as before.

Proceeding in the same way, the positions *p*, *q*, *r*, and *s* of the center of the eccentric, when the piston has moved 12, 16, 20, and 24 in. of its stroke, may be laid down in Plate II. The edges of the steam and exhaust-ports and the center line *g E* are extended downward, and the line *C E* is made equal to the stroke of the piston. Horizontal lines 8 16', 12 12', 16 8', etc., are drawn at a distance from *f f'* equal to the movement of the piston. The different positions of the valve indicated in figs. 15 to 21 are then laid down on these lines.

We now have a graphical representation of the movement of the valve in seven successive positions of a stroke. The position of the outer edge of the valve, which controls the admission of steam, is shown, in its relation to the port *e*, at *M*, *N*, *O*, *P*, *Q*, *R*, and *S*, and the inner edge which controls the exhaust is shown at *M'*, *N'*, *O'*, *P'*, *Q'*, *R'*, and *S'*. It will be seen that at *N* the steam-port is wide open, and remains so until the valve gets into the position shown at *P*, when it begins to close the port. At *R* it is almost entirely closed. If now we draw a curve *M N O P Q R S* through the edge of the valve in its successive positions, that curve will show the movement of the valve in relation to the steam-port during the whole stroke. Horizontal lines 1 23', 2 22', 3 21', etc., have been drawn between *f f'* and 4 20' to represent each inch of the stroke, and the spaces between these lines has been subdivided by other lines which represent eighths of an inch, and the whole distance from *C* to *E* has been subdivided in the same way. The relation of the curve *M N O–S* to these horizontal lines will show exactly the position of the outer or steam admission edge *M* of the valve at all points of the stroke of the piston. Thus the distance of the curve on the line 1 23' from the outer edge of the port *c*, as indicated by the dotted line at *w*, shows how wide the port was open when the piston had moved 1 in. of its stroke. A similar dotted line at *x* shows the width of opening at 14 in. of the stroke, and the intersection of the curve with the outer edge of the port at 20 in. of the stroke shows that the port was then closed and the steam cut off.

A similar curve *M' N' O' P' Q' R' S'* shows the position of the inner or exhaust edge *M'* of the valve in relation to the port *e*. Other curves *S U M* and *S' U' M'* have also been drawn which represent the movement of the valve during the return stroke of the piston. The dotted line below *R'* shows the width of the opening of the port *e* to the exhaust when the piston had moved $20\frac{1}{2}$ in., and the intersection at *y* shows that the port was closed to the exhaust at $22\frac{7}{16}$ in. of the stroke.

The slight intersection of the curve *S U M* with the outer edge of the port *c* just below *M* shows that the port was slightly opened before the piston had reached the end of its stroke, and the intersection at *z* shows that the port *e* was opened to the exhaust when the piston still had to move 1 in. to complete its stroke.

It will thus be seen that such diagrams show very plainly the movement of a valve, and they present to the eye a diagram which shows its different positions during a whole revolution of the crank. A clearer idea may thus be formed of its action than it would be possible to have without some such a graphical representation.

QUESTION 119. *Can the drawing of such diagrams be simplified in any way?*

Answer. Yes; if it is observed that the only way in which the rocker effects the movement of the eccentric and valve is to reverse their motions in relation to each other. We may, for simplicity, suppose the rocker is removed and that the shaft and eccentric are located at *T'* above *T* and opposite to the valve, and that the eccentric is connected by a rod *m" D*, directly with the valve. In that case, in order to move the valve in the same direction that it was moved with the rocker, it will be essential that the center *m"* of the eccentric be in the opposite position in its path from that in which it is shown at *m* below. This will be plain if the reader will follow the motions indicated by the darts at *m Y X* and *H*, and then observe the direction that *m"* and *H* are supposed to be moving. It should be observed that the center *m"* must be on the right side of the center line *T' T* instead of the left, and that the distance *m'' m"* from the center line must be the same as *m m'* equal to *j k* or $1\frac{1}{16}$ in.

On the middle of *C E*, the vertical center line of the valve-face, we will now take *A* as a center, and draw a circle *m"" n"–s"* to represent the path of the center of the crank-pin. It will also be imagined that the center *T* of the shaft is located at *A*, and that the circle *m"" n"–s"* represents the path of the center of the eccentric, and that its center *m""* occupies the same relation to the center line *C E* that *m"* does to *T' T*—that is, it is $1\frac{1}{16}$ in. to the right of *C E*. If now we draw a vertical line through the center *m""* of the eccentric upward it will coincide with *i h*, the center line of the valve. By drawing a line *A u* through the center *m""* of the eccentric to the circumference of the large circle, which represents the path of the center of the crank-pin, and then from *u* the intersection of this line with the large circle, laying off a space *u v* equal to 45 degrees, and draw a line *v A*, the intersection of this line at *n"* with the path of the center of the eccentric will give the position of its center when the piston has moved 4 in. The successive positions *o" p" q"*, etc., of the curve of the eccentric can then be laid out in the way described, and by drawing perpendicular lines through these centers they will give the corresponding positions of the centers of the valve.

QUESTION 120. *What is the effect of increasing the lap of a valve if the travel remains the same?*

Answer. It shortens the period for the admission of steam--that is, it cuts the steam off earlier in the stroke. It also closes and opens the ports to the exhaust earlier. Thus in fig. 70 motion curves have been drawn for a valve with $1\frac{1}{4}$ in. lap and $4\frac{1}{2}$ in travel. From the steam curve *M N–S* it will be seen that the steam-port is closed at *q* or at $16\frac{1}{2}$ in. of the stroke instead of $20\frac{1}{4}$, as it is when the valve has $\frac{3}{4}$ in. lap, as shown in Plate II. The exhaust curve *M' N'–S'* shows that the port *e* is closed on the exhaust side at $21\frac{1}{4}$ in. instead of $22\frac{3}{8}$ in., and that on the return stroke it opens the port to the exhaust at $21\frac{1}{4}$ in. instead of 23, as shown in Plate II.

It will also be seen that with the proportions of the valve and the travel represented in fig. 70, that the steam-port *c* is not opened wide at any period of the stroke.

QUESTION 121. *If the lap remains the same, what is the effect of reducing the travel?*

Answer. 1. Whenever the travel is less than twice the lap added to twice the width of one of the steam-ports, the latter will not be opened wide. This was shown in fig. 70, in which the valve has $1\frac{1}{4}$ in. lap and the steam-port is $1\frac{1}{4}$ wide, so that $1\frac{1}{4}+1\frac{1}{4}\times 2=5$ in. As the travel is only $4\frac{1}{2}$, the valve does not move far enough to uncover the steam-port completely. It is also shown in fig. 71 with a valve having $\frac{3}{4}$ in. lap and a travel of $3\frac{1}{2}$—represented by the motion curves drawn in full lines. It will be seen at *w'* that the greatest width of opening of the port is only $\frac{7}{8}$ in. The dotted curves show the motion of the valve with $2\frac{3}{4}$ in. travel. They show at *w* that the maximum opening of steam-port is only $\frac{1}{2}$ in.

2. The period of admission is reduced or the steam is cut off shorter. At *q* and *q'* in fig. 71 the motion curves show that the valve closes the steam-port at $13\frac{1}{4}$ and $17\frac{1}{2}$ in. of the stroke instead of $20\frac{1}{4}$ in. with $4\frac{1}{2}$ in. travel, as shown in Plate II.

3. The steam-port is closed and opened to the exhaust earlier. Thus at *y* and *y'* the curves show that the steam-port *e* is closed at $19\frac{5}{8}$ and $21\frac{1}{4}$ in. of the stroke instead of $22\frac{1}{2}$, as shown in Plate II, with $4\frac{1}{2}$ in. travel. At *z* and *z'* the curves show that the port is opened on the exhaust side at $21\frac{1}{8}$ and $19\frac{3}{8}$ in. of the stroke instead of 23 in.

4. The valve opens the steam-port for the admission of steam earlier with a short travel than with a long one. This is indicated by the two curves just below *M*, fig. 71. The full line shows that the port is opened when the piston still has $\frac{3}{16}$ in. to move before completing its stroke. The dotted curve, which shows the movement of the valve with a shorter travel, indicates that the valve opens the port, while the piston still has $\frac{7}{16}$ in. to move before it reaches the end of its movement.

QUESTION 122. *What occurs when the valve closes communication between the steam and exhaust-ports before the piston has completed its stroke?*

Answer. The steam contained in the cylinder in front of the piston is compressed by it, and it thus acts as a cushion to resist the momentum of the moving parts, which must come to a state of rest at the end of the stroke.

QUESTION 123. *What occurs when the valve closes communication between the exhaust-port and the steam-port ahead of the piston?*

Answer. The steam which has not been exhausted from the cylinder is enclosed in it and is compressed by the advancing piston, and it thus acts like the pre-admission of steam before the piston has completed its stroke—that is, as a cushion to resist the momentum of the piston and bring it to a state of rest.

QUESTION 124. *Does this compression result in any loss of energy?*

Answer. No, because the power required to compress the confined steam is again given out by its expansion behind the piston on its return stroke. In fact, it results in a direct economy, because by the compression of the confined steam the clearance spaces and steam-ways are filled with steam of a high pressure. Without such compression it would be necessary to fill them with live steam when the steam-port is opened.

QUESTION 125. *What is the effect of inside lap?*

Answer. It delays the release or exhaust of steam and increases the compression. For this reason no inside lap is usually given to valves for engines which run at a high rate of speed, as with it the exhaust steam has not time enough to

escape freely. In fact, in some cases what is called *inside clearance* is given to valves—that is, the width of the exhaust cavity of the valve is made somewhat wider than the distance over the inner edges of the steam-ports, so that it does not entirely cover them when it is in the middle of the valve-face. The effect of inside clearance is just the reverse of that produced by inside lap—that is, it causes the release to occur earlier in the stroke and compression later.

CHAPTER VII.

RESOLUTION OF MOTION AND FORCES.

QUESTION 126. *When one object is moved by two forces acting simultaneously in different directions but not opposite to each other, what occurs?*

Answer. It moves in the shortest path between the point from which it starts to that which it would reach in a given time if acted upon by each of the forces separately.

QUESTION 127. *How can this be shown?*

Answer. This will be made apparent if it be supposed that a billiard ball or other object is rolled on the floor of an elevator, used for raising and lowering goods or passengers, while the elevator is ascending or descending. Thus let *A*, fig. 72, repre-

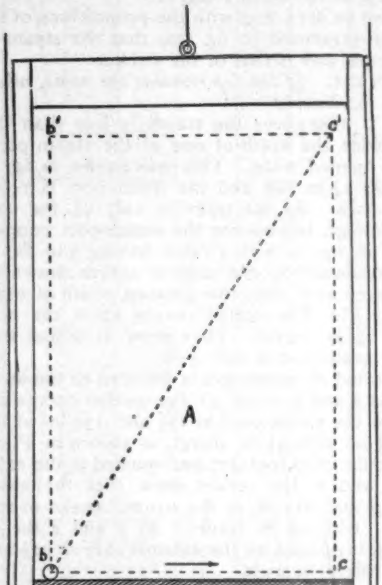


Fig. 72

sent a vertical section of the elevator, and *b* a billiard ball. If the distance from *b* to *c* is equal to 4 ft., and that from *c* to *c'* equal to 6 ft., then if the ball is rolled from *b* to *c* at the rate of 4 ft. per second while the elevator is standing still, the horizontal dotted line *b c* would represent its path. But if the ball is not rolled, and the elevator ascends at the rate of 6 ft. per

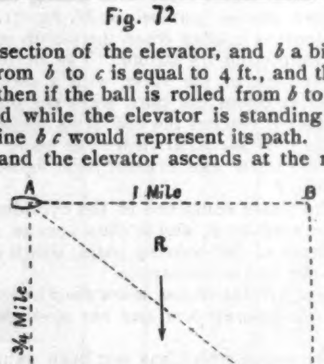


Fig. 73

second, then the vertical dotted line *b b'* would represent its path. If, however, the elevator is going up at the same time that the ball is rolling, then, while the latter is moving horizontally 4 ft., from *b* to *c*, it is also ascending 6 ft., so that its path would be represented by the diagonal line *b c'*.

The same principle is also illustrated if a boat is rowed across a river which flows at a rate of, say, three miles an hour. If the river is a mile wide, and the boat is rowed at a speed of four miles an hour, it will take a quarter of an hour to cross. But while the boat is being rowed across it also drifts three-quarters of a mile down-stream with the current, as illustrated in fig. 73, in which *R* is the river and *A* the starting point of the boat. If there was no current in the river and the boat was rowed in the direction *A B* at the speed mentioned, it would cross and reach *B* in a quarter of an hour. On the other hand, if it were allowed to drift with the current and were not rowed, it would float down stream three-quarters of a mile to *C* in the same time. If when the boat reached *C* there was then no current, and the boat was rowed across, it would reach *D* in 15 minutes after leaving *C*.

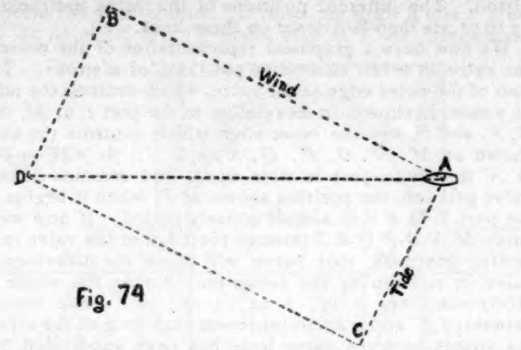


Fig. 74

If, however, the boat starts from *A* and is rowed in the direction *A B* while it is crossing, it will simultaneously drift downstream with the current, so that it will take the diagonal path *A D*, and will reach *D* in the same time that would be required to row from *A* to *B* or *C* to *D* if there was no current, or to float from *A* to *C* if the boat was not rowed.

QUESTION 128. *How can we determine graphically the direction and distance which an object like a boat will move if acted upon by two forces as described?*

Answer. If we will draw one line *A B*, whose direction and length represents to any convenient scale the direction and the

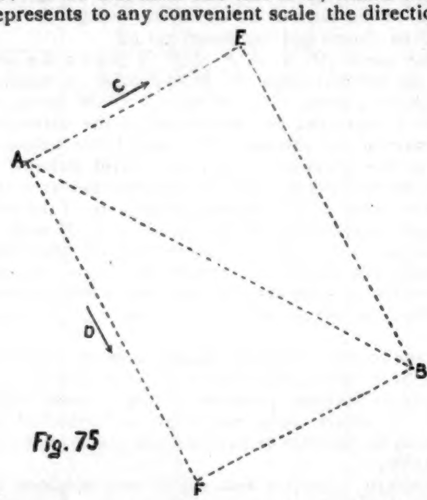


Fig. 75

distance that the body would be moved by one force in a given time, then draw another line, *B D*, representing in the same way the direction and distance that the object would be moved by the other force, and then draw a diagonal line from the starting point *A* to the terminal point *D*. Or we may proceed in the reverse order and draw *A C* first, and then make *C D* equal and parallel to *A B*, and then complete the diagram with the diagonal line *A D*. It should be noticed that *A B* must be equal and parallel to *C D*, and *A C* equal and parallel to *B D*, so that the line *A D* is a diagonal of a parallelogram whose sides are equal and parallel to the direction of the two forces which simultaneously act upon the body.

In fig. 72 the lines *b b'* and *c c'* are equal and parallel, and so are *b c* and *b' c'*, so that *b c'* is a diagonal of the parallelogram *b b' c' c*. Hence, we see that the motion which results from the action of two forces, or the "*resultant*," as it is called, is the diagonal of a parallelogram, the sides of which represent the extent and direction of the motion which would have been produced by each force acting separately.

QUESTION 129. *How is the general principle stated in scientific language?*

Answer. It is said by Rankine: "If two forces whose lines of action traverse one point be represented in direction and magnitude by the sides of a parallelogram, their *resultant* is represented by the diagonal."

QUESTION 130. *How can this be still further illustrated?*

Answer. Let it be supposed that a sail-boat *A*, fig. 74, is

acted upon by the wind so that in a given time, say a half hour, it would be moved in the direction and a distance represented by the line *A B*, and that in the same time the tide would carry it from *A* to *C*. Now, lay down *A B* representing the effect of the wind, and *A C* that of the tide, and draw *B D* equal and parallel to *A C*, and *D C* equal and parallel to *B A*, then the diagonal *A D* will represent the direction and the distance the boat will move under the combined effect of wind and tide.

QUESTION 131. *What is the movement which results from the combined action of two or more forces, and which in figs. 73, 74, and 75 is represented by the diagonals of the parallelograms, named?*

Answer. It is named the "*resultant.*"

QUESTION 132. *What are the forces represented by the sides of the parallelogram, and which act upon a body to produce the resultant, called?*

Answer. They are called the "*components.*"

QUESTION 133. *If we have a resultant and wish to ascertain two components acting in given directions which would produce the resultant, how can we do it?*

Answer. This can be done by drawing a line representing the resultant in direction and length; then from its extremities lines must be drawn representing the direction of the components. A parallelogram will thus be constructed of which the resultant is the diagonal, and the sides will represent the components. Thus, suppose *A B*, fig. 75, represents the direction and the distance which a boat is carried by the combined action of the wind blowing in the direction *A E*, and of the tide flowing from *A* toward *F*; if we want to find out how far the wind or how far the tide would carry the boat in the time that it moves from *A* to *B*, we draw the line *A E* through *A* in the direction of the wind, and *A F* also through *A* in the direction of the tide. We then complete the parallelogram by drawing *B E* through *B* and parallel to *A F*, and *F B* parallel to *A E*. Then the side *A E* represents the distance the tide would carry the boat, and *A F* that which the wind would move it while it is going from *A* to *B* under their combined influence.

QUESTION 134. *What is the process by which two motions are resolved into one, or one into two, which has been described, called?*

Answer. It is called the "*composition of motion.*"

QUESTION 135. *Can the effect of two forces or strains acting simultaneously on a body be represented in the same way?*

Answer. Yes.

QUESTION 136. *How is a force or strain represented by a line?*

Answer. Forces are compared to or measured by the downward pressure which a 1-lb. weight exerts at the surface of the earth, so that it is easy to conceive that the magnitude of a pushing or pulling force may be described as equivalent to so many pounds. We may therefore take any length of line to represent one pound; that is, a line one inch long may repre-

Fig. 76

sent a pound, one 2 in. would represent 2 lbs., and one 6 in. long 6 lbs., etc. Or we may take one-eighth of an inch to represent a pound, as in fig. 76, in which the weight *W* is supposed to be equal to 10 lbs., and the line *a b* is made equal to ten-eighths, or $1\frac{1}{4}$ in., and thus represents the magnitude of the force or weight *W*. In the same way, if a horse was pulling on a rope and exerted a strain of 100 lbs., we may make 1 lb.$=\frac{1}{100}$ of an inch, so that a line *a b*, fig. 77, 1 in. long will represent the force or strain which the horse is exerting on the rope. Or, taking the illustration of the boat in fig. 73, it may be supposed that the person rowing it exerts a force of 24 lbs., while the current of the river is equal to 18 lbs. This diagram has been drawn so that one-sixteenth of an inch is equal to one pound. The line *A B* is therefore $1\frac{1}{2}$ in. long, and *A C* $1\frac{1}{8}$ in. long. If the parallelogram is completed the length of the diagonal *A D* will then represent the resultant of the two forces, or their combined effect on the boat in the direction *A D*.

From what has been said, it will be seen that a line may be made to represent the magnitude of a force, and also the direction in which it is exerted. Thus, in fig. 76 the line *a b* represents a force which is exerted downward; in fig. 77 the force represented by *a b* is exerted horizontally, and in fig. 74 *A D* acts diagonally. Therefore it is plain that the length and position of a line may be made to represent the magnitude and direction of a force.

Fig. 77

QUESTION 137. *Does the principle of the composition of motion apply to forces or strains exerted by bodies at rest?*

Answer. Yes.

QUESTION 138. *How can we show this experimentally?*

Answer. If we will suspend a weight *W*, fig. 78, equal, say, to 10 lbs., by two inclined cords *b f* and *b g*, which pass over pulleys *f* and *g*, it will be found that the weights *A* and *B*, which will balance *W*, can be determined as follows: As the force exerted

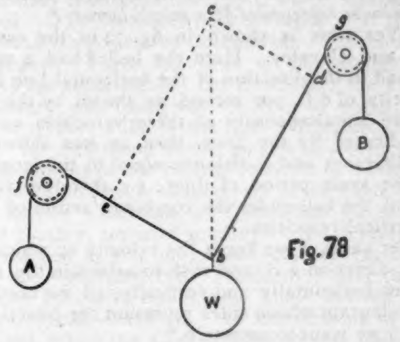


Fig. 78

by the weight *W* acts downward, its direction is represented by the perpendicular line *b c*. If now we lay off the distance *b c* to any convenient scale, say $\frac{1}{8}$ in.$=1$ lb., to represent the weight *W*, and then draw the lines *c d* and *c e* parallel to *f b* and *g b*, then *c d* or *e b* will represent the strain on the cord *b f* and *c e*,

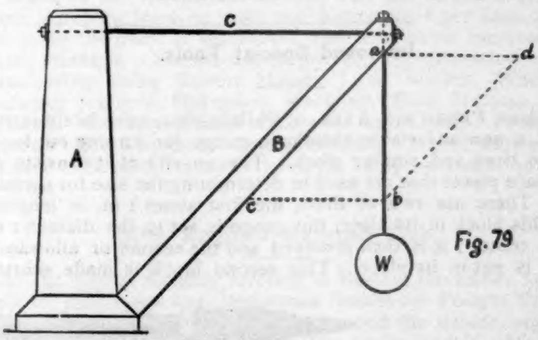


Fig. 79

or *d b* will represent that on *b g*, and they will be equal to the weights *A* and *B*, which will balance *W*. Hence, we see again that the *resultant* of two forces is the diagonal of a parallelogram, the sides of which represent the direction and magnitude of those forces.

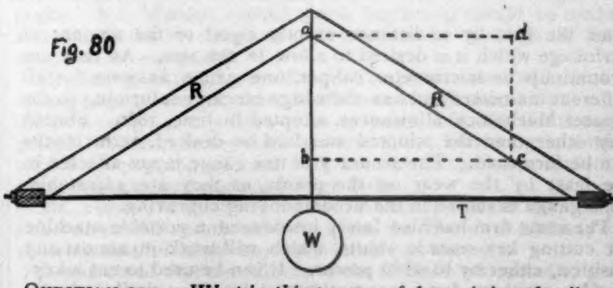


Fig. 80

QUESTION 139. *What is this process of determining the direction and magnitude of three or more forces called?*

Answer. It is called the "*composition of forces,*" and a figure like *c e b d* is called a "*parallelogram of forces.*"

QUESTION 140. *What other illustrations may be given of the application of this principle?*

Answer. The strain on the parts of a common crane for lifting heavy objects can be deduced in this way. Thus, let A represent the post, B the jib, and c the tie rod of such a crane. If W equals 1,000 lbs., if we make $a\ b = 1{,}000$, and draw $b\ c$ parallel to C, then the length of the line $c\ b$ will represent the strain on the rod C and $c\ a$ that on the strut B. It will be plain from the figure and a little reflection that the effect of the weight W will be to compress B and pull C apart. Therefore B is said to be subjected to a *strain of compression* and C to one of *tension*. If the parallelogram of forces was completed the line $a\ d$ would be drawn parallel to C and to $c\ b$, and $b\ d$ parallel to B or $c\ a$. In most cases all that is needed to determine a strain on a structure is to draw a triangle like $a\ b\ c$, which is one-half of the parallelogram $a\ c\ b\ d$.

A roof or bridge truss like that shown in fig. 80 is another illustration of this principle. In this $R\ R$ are the timbers or rafters, and T a tie-rod, and W a weight resting on the rafters. If $a\ b$ is made equal to W, and $b\ c$ drawn parallel to T, then $a\ c$ will represent the strain on R and $b\ c$ that on T. If the inclination of the timbers $R\ R$ is the same, they will each be subjected to an equal strain, and the foot of the one will push against the tie-rod with a force just equal to that exerted by the other timber at the opposite end.

QUESTION 141. *Can the velocity in different directions of a moving body also be represented by a parallelogram?*

Answer. Yes, this is shown in fig. 72 in the case of the billiard ball and elevator. Here the ball b had a velocity of 4 ft. per second in the direction of the horizontal line $b\ c$, and a vertical velocity of 6 ft. per second, as shown by the line $b\ b'$. If it is moved simultaneously at these velocities and in the directions indicated by the lines, then, as was shown, it will move in a direction and a distance equal to the length of the line $b\ c'$ in the same period of time; $b\ c'$ therefore represents the velocity of the ball under the combined action of the horizontal and vertical velocities.

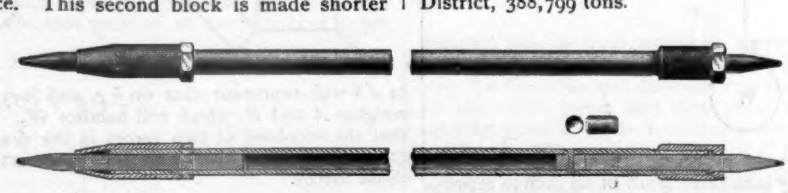
On the other hand, if we know the velocity at which the ball moves in the direction $b\ c'$, and wish to ascertain the speeds at which it moves horizontally and vertically, all we need do is to draw a parallelogram whose sides represent the direction of the velocity which we want to ascertain.*

(TO BE CONTINUED.)

Manufactures.

Improved Special Tools.

MESSRS. PEDRICK & AYER, of Philadelphia, have lately introduced a new adjustable shrinkage gauge for turning out locomotive tires and similar work. The novelty of it consists of the space pieces that are used in determining the size for shrinkage. There are two of them, the first about 1 in. in length; with this block in its place, the gauge is set to the diameter of wheel center; it is then removed and the second or allowance block is put in its place. This second block is made shorter than the first by a distance exactly equal to the amount of shrinkage which it is desired to allow in the tire. As they are ground up to micrometer caliper, one gauge answers for all different diameters and has shrinkage blocks conforming to the Master Mechanics' allowances, adopted in June, 1886. Should any other than the adopted standard be desired, extra blocks can be furnished. The accuracy of this gauge is not affected in the least by the wear on the points, as they are adjustable. This gauge is shown in the accompanying engraving.



The same firm has also lately introduced a portable machine for cutting key-seats in shafts, which will work in almost any position, either by hand or power. It can be used to cut a key-seat in an axle under a locomotive and in many similar places, where the work is usually very difficult.

* The principle of the resolution of motion, forces and velocities has a direct application to the action of the piston, connecting-rod and crank, which will be discussed in the next chapter.

Electric Street Cars.

CARS on the Van Depode system receiving their power through a traveler on an overhead conductor, are to be run on the street railroad between Brooklyn, N. Y., and Jamaica. The electric plant is now nearly completed.

The Richmond Union Passenger Railroad has nearly completed its line, and it will be in operation early in January. The power is taken from overhead wires. The cars are to be heated in winter by Burton's electric heater.

The West End Company in Boston is experimenting with a car fitted with a Weston motor, the power being derived from storage batteries on the Julien system.

Manufacturing Notes.

THE Tanner & Delaney Engine Company of Richmond, Va., has changed its name to the Richmond Locomotive & Machine Company. The plant has been considerably extended, and the company is prepared to build stationary engines, general machinery, and locomotives.

THE Ensign Car Works at Huntington, W. Va., are building for the Louisville & Nashville road 1,000 flat cars 34 ft. long and having a capacity of 60,000 lbs. each.

THE Canadian Locomotive & Engine Company at Kingston, Ont., has a contract for 14 locomotives for the Intercolonial Railway.

THE Baldwin Locomotive Works in Philadelphia are building 25 freight engines for the Philadelphia & Reading road.

THE East Chicago Steel Works at Hammond, Ind., are now in operation. The Bessemer steel plant consists of two 3-ton converters and a blooming mill, and its full capacity is 250 tons a day.

THE Manchester Locomotive Works at Manchester, N. H., are at work on a heavy order for the Atchison, Topeka & Santa Fé Railroad.

A CHARTER for a corporation to be known as the Oliver Iron & Steel Company of Pittsburgh has been granted. The corporators are Henry W. Oliver, Jr., David B. Oliver, James B. Oliver, John Phillips, and John Smith. The capital stock of the new company will be $1,500,000. It is a reorganization of the present company of Oliver Brothers & Phillips, with a limited liability.

THE Pittsburgh Tube Works have taken a contract to furnish 68 miles of wrought-iron pipe, to be used to carry water for irrigating purposes near Los Angeles, Cal. Most of the pipe will be 2 in. in diameter.

IRON-ORE shipments from the Lake Superior region this year have been 4,283,169 tons, an increase of 1,142,764 tons (36¼ per cent.) over 1886. Of this year's shipments, the Marquette District furnished 1,736,811 tons; the Menominee District, 1,116,832 tons; the Gogebic District, 1,040,727 tons; the Vermillion District, 388,799 tons.

THE Morgan Engineering Company at Alliance, O., has received the contract for the two large overhead traveling cranes for the gun-shop at the Washington Navy Yard. One of them is to be finished in 12, the other in 15 months. The leading dimensions are: One to have a span of 62 ft., at a height of about 40 ft. above floor line. This crane will have a capacity to lift guns weighing 125 tons, about 200 ft. travel lengthwise, and about 50 ft. crosswise of shops, and will be one of the largest cranes ever built in the world. The other crane is to have a span of about 52 ft., to have a lifting capacity of about 45 tons, to have a travel of about 480 ft. These cranes will cover workshops respectively of about 220×62 ft. and 480×52 ft., with a lift of about 40 ft. Each of the cranes is so designed as to have various speeds of hoist and travel in all directions to suit the varying weights of loads, from the lightest to the greatest or maximum loads, the lightest loads being handled in all directions rapidly, and the heaviest at speeds to suit the greatest activity such loads could be handled. Automatic stop-motions

are placed on the various motions that automatically prevent the travel of cranes in any direction beyond their maximum limits.

Marine Engineering.

THE Pusey & Jones Company in Wilmington, Del., recently launched the iron steamer *Manteo* for the Old Dominion Steamship Company. The principal dimensions are: 190 ft. long on the water-line, 26 ft. beam, 10 ft. 3 in. depth at side, moulded, and she is provided with a compound surface-condensing engine with cylinders 17 and 34 in. diameter, 28-in. stroke, and two Scotch boilers, 8 ft. diameter, 12 ft. long, built for a working pressure of 105 lbs. per square inch. The boat is designed for passengers and freight, and has 15 state-rooms.

CHARLES P. WILLARD & Co., of Chicago, have built a 70-ft. twin-screw passenger steamer for Oteri & Co., agents of the Pacific Mail Steamship Co., at Buenaventura, United States of Colombia. The steamer will be used for carrying passengers to Panama from Buenaventura.

THE Harlan & Hollingsworth Company in Wilmington, Del., is to build a new propeller to run between Wilmington and Philadelphia. The boat is to be 185 ft. long, 28 ft. beam, 40 ft. wide over the guards, and 10 ft. depth of hold. The engine will be of the triple-expansion type with surface condenser, with cylinders 18½, 27, and 42 in. diameter, and 24-in stroke. There will be two steel boilers of the locomotive type 8 ft. diameter and 23 ft. long, which will carry 160 lbs. working pressure.

THE Western Transit Company of Chicago has contracted with the Detroit Dry Dock Company of Wyandotte, Mich., for an iron steamer of 2,700 tons capacity. She will be propelled by a triple-expansion engine, with cylinders 23, 36, and 62 in. diameter and 48-in. stroke.

THE surveying parties for the Nicaragua Canal will have with them 13 steel canoes, seven 18 ft. and six 20 ft. long. These canoes were designed by William Cowles and built by L. H. Raymond at Greenpoint, N. Y. The parties are also supplied with a 20-ft. surf-boat of steel.

IT is stated that the first iron steamer built in America was the *Bangor*, launched at Wilmington, Del., from the yard of Betts, Harlan & Hollingsworth, in 1845. The *Bangor* was a screw steamer of 250 tons measurement, schooner-rigged, and was built to run between Boston and Bangor.

THE Colombia Navigation Company has made a contract with Pittsburgh parties for a stern-wheel steamer with steel hull, to run on the Atrato River in Colombia, South America. The boat is to be 166 ft long, 32 ft. beam, and 6 ft. depth of hold, and is not to draw over 52 in. of water when loaded. This is an order which, it was thought recently, would go to English parties.

Proceedings of Societies.

American Society of Civil Engineers.

A REGULAR meeting was held at the Society's House in New York, December 8. A resolution was passed fixing the dues for the proposed new grades for students and associate members, which it was deemed necessary to do at this meeting in order to comply with the constitution. The resolution specifies that in the event of the adoption of the grades of associate member and student the dues for associate members shall be the same as now fixed for associate, and the dues for the student grade shall be $10 for resident and $6 for non-resident students.

The Secretary then read the closing discussion on William Metcalf's paper on Steel, Some of its Properties; its Use in Structures and in Heavy Guns, which was read by the author March 2, 1887. This was followed by a paper giving some experiments on the Protection of Piles from Limnoria and Teredo in San Francisco Bay, by Marsden Manson.

The following gentlemen were elected members: Tucker Carrington Eggleston, Richmond, Va.; Charles Edward Newham, Vincennes, Ind.; Henry Bowman Seaman, Philadelphia, Pa. Juniors: William Pierson Field, Newark, N J.; Robert Van Arsdale Norris, Wilkesbarre, Pa.

Engineers' Society of Western Pennsylvania.

AT the regular meeting in Pittsburgh, November 15, the discussion of Mr. Ramsay's paper (on the Effect of Temperature on Iron and Steel) was continued by Messrs. Buchanan, Roberts, Reese, Phillips, Brashear, Ferris and Munroe.

Mr. C. P. Buchanan then read a paper on Tests of Steel Beams, giving data of some tests made on steel for girder bridges in the hydraulic testing machine of the Keystone Bridge Company.

Engineers' Club of St. Louis.

THE Club met December 7, President Potter in the chair, 29 members and 3 visitors present. The Executive Committee recommended Reno De O. Johnson, Oscar W. Raeder, James C. Simpson, and Albert H. Zeller for election to membership. On being balloted for, all were elected.

The Committee on nominations of officers for the coming year reported: For President, M. L. Holman; Vice-President, J A. Ockerson; Secretary, William H. Bryan; Treasurer, C. W. Melcher; Librarian, J. B. Johnson; directors, William B. Potter and F. E. Nipher. On vote the report was accepted.

The Secretary then read his report, which was accepted and ordered filed. The Treasurer read his report. It was accepted and referred to the Executive Committee. The Librarian made a verbal report. There had been no happenings out of the usual line in his department. He mentioned the excellent service the library was doing for students of engineering; also promised to prepare a list of the Club's literature for use of the members. He mentioned having picked up a copy of Volume I of the *Transactions* of the British Institute of Civil Engineers, which would be accessible to members of the Club.

Robert Moore, Chairman of Committee on relations with Mercantile Library, reported progress. No definite agreement had been reached as yet, but he felt confident the Club's wants would be fully provided for. President Potter then read the report of the Executive Committee, which showed the Club to be in a prosperous condition. An amendment to the by-laws was proposed, which the Club decided to vote upon at the next meeting in the usual way.

P. M. Bruner then read a short paper on the Action of Frost on Concrete Work. He explained the difficulties met with, and reported the results of a series of experiments he had made on Portland cement; also offered suggestions for counteracting the influence of low temperatures. He said the addition of salt would lower the freezing point one degree for 1 per cent. addition up to the point of saturation, and would also increase the tensile strength. The discussion proved very interesting, those participating being Robert Moore, J. A. Seddon, Wheeler, Professor Johnson, Ockerson, Macklind, Flad, Holman, and Caldwell. But few reliable data were to be had. Professor Johnson offered to make a series of tests. It was shown that the best work was secured between the temperatures of 45° and 70° Fah.

New England Railroad Club.

AT the regular monthly meeting in Boston, December 14, the topic for discussion was Continuous Brakes for Freight Trains.

Mr. Lauder, of the Old Colony, opened the debate, arguing strongly in favor of the Westinghouse brake, and Mr. Marden, of the Fitchburg road, took the same ground. Mr. Adams, of the Boston & Albany, thought the Westinghouse brake was a good thing, but suggested that the trouble is that roads receive cars from so many other roads, it will be many years before it will be possible to run freight trains with the Westinghouse brake. Mr. Marden replied that a beginning should be made, and that if the Westinghouse is to be put on all cars, the first one must be equipped.

Mr. Smith, of the Boston Forge Company, asked what is the average age of freight cars, and it was stated that the average life of a freight car is from 11 to 15 years, and Mr. Smith suggested that that fact would indicate about how long it would take for equipping all cars with continuous brakes, providing every new car was equipped when built.

Mr. Turner, of the Turner-Beard Automatic Brake Company, referred to the recent exhibition on the Boston & Albany as showing that his brake has considerable power.

It was voted that the officers of the Club be instructed to prepare a circular, to be submitted to the various railroads of New England, asking them to appoint a representative to meet in national convention for the purpose of selecting a standard coupling for steam connections between passenger cars, such convention to meet at the call of the Committee appointed at the November meeting in New York.

The subject of heating cars with steam from the locomotive was taken up and discussed a short time, the special point considered being the ability to heat 10 or 12 cars with the thermometer below zero.

Engineers' Club of Philadelphia.

A REGULAR meeting was held at the House of the Club in Philadelphia, November 19, President T. M. Cleemann in the chair; 35 members and 1 visitor present.

The Secretary presented, for Mr. W. H. Nauman, a paper upon the Calorimetric Investigation of the Performance of a Compound Engine, embodying considerable tabular data.

Mr. J. E. Codman presented a description, illustrated by specimens, etc., of Cement Tests, showing the effect the shapes of specimens had upon the results.

There was some discussion by Mr. A. Marichal.

The Secretary presented, for Mr. C. H. Haswell, a specimen of Cement.

The discussion of Mr. C. G. Darrach's paper upon Boiler Specifications was continued by Messrs. J. T. Boyd, O. C. Wolf, P. Roberts, Jr., A. Marichal, and the Secretary. The Secretary presented a communication thereon from Mr. G. R. Henderson.

A REGULAR meeting was held in Philadelphia, December 3, at which nominations were made for officers to be voted for at the annual meeting.

Mr. Percy T. Osborne presented an illustrated paper on the Palmetto Railroad, the connecting link in a new through line to the South.

Mr. R. B. Osborne presented an illustrated paper upon the Unaccountable Deficiency in the Track of American Railways. Mr. Osborne deprecated the continued use of the unsatisfactory spike; offered a suggestion for a spike-headed bolt--partly in accordance with established English practice and partly of his own design—to pass entirely through the tie; stated that this design was in no way patented; and particularly requested full discussion of the subject by the members of the Club.

Considerable informal discussion followed.

The Secretary presented to the Library, on behalf of Messrs. R. B. & P. T. Osborne, Active Members of the Club, a handsome copy of Williams's copper-plate mounted Map of the United States, Canada, Mexico, Central America, West Indies, etc., which was received with a vote of thanks.

Engineers' Club of Kansas City.

A REGULAR meeting of this Club was held December 5. The Secretary read, in the absence of the author, a paper entitled Deviation of the Ship's Compass, written for the Club by Mr. H. C. Pearsons, of Ferrysburg, Mich.

After a brief discussion it was moved by Mr. Mason that a vote of thanks be extended to Mr. Pearsons for his valuable paper, and to Mr. Kiersted for the paper presented at the previous meeting. The motion was carried.

Mr. J. A. L. Waddell then read some abstracts from a paper on General Specifications for Highway Bridges of Iron and Steel, describing at length the letting of county bridges with some defects of methods in use.

Notice was given by the President that the annual meeting would be held December 19.

Civil Engineers' Society of St. Paul.

AT the October meeting of this Society in St. Paul, Vice-President Wood occupying the chair, the report of the Committee upon the entertainment of the American Water Works Association, at its meeting in St. Paul in July, was read and accepted. A vote of thanks was passed and also resolutions thanking the Engineers' Club of Minnesota for their kindness and courtesy in the reception and entertainment given by them to the members of this Club on the evening of September 15 at Minneapolis.

The paper of the evening was read by Mr. A. Munster upon the Calculation of Plate Girders. Mr. Munster discussed the formulæ in common use, showing their absolute errors, which vary to a large extent, and seriously impair the value of the results obtained by their use, as the errors amount not seldom to from 6 to 12 per cent., and frequently even more. Two original formulæ were proposed by Mr. Munster, which are at the same time much nearer accuracy and also easier of application.

This paper was discussed by the members present.

Master Car-Builders' Association.

THE Sub-committee appointed by the Executive Committee of the Master Car-Builders' Association to examine and report what couplers come within the limits established for the M. C. B. standard type, met in Washington, December 13. There were present E. B. Wall, Chairman; R. D. Wade, John S. Lentz, Godfrey W. Rhodes, John W. Cloud; M. N. Forney, Secretary. Representatives of a number of couplers were also present.

A special committee, consisting of Messrs. Wall, Cloud, and Forney, was appointed to adopt standard lines showing the form and the length of couplers, and was instructed to report to the Sub-committee.

The Sub-committee has made such arrangements with the representatives of the owners of the Janney patents in regard to the use of the lines of that coupler as will secure a satisfactory understanding with the railroad companies, through the Sub-committee, for the use of those lines should the Committee see fit to adopt them; such arrangements to be fully consummated before the Sub-committee makes its report to the Executive Committee.

Railroad Spring Manufacturers' Association.

A MEETING was held in Pittsburgh, November 29, at which all the makers of car-springs were represented. An Association with the above title was formed, and the following officers were chosen: President, Benjamin F. Atha, Newark, N. J.; Vice-President, Joel Farist, Bridgeport, Conn.; Secretary, Edward Guibert, New York; Executive Committee, Charles Scott, Philadelphia; Aaron French, Pittsburgh, and A. Delano, Detroit, Mich. Another meeting will be held early in January in New York.

American Society of Mechanical Engineers.

THE eighth annual meeting began in Philadelphia, November 28, with an evening session at the Continental Hotel.

President George H. Babcock delivered the annual address. He laid great stress upon the importance of mechanical engineering, and said that "the profession of the mechanical engineer underlies all forms of engineering, as well as architecture, manufactures, and commerce, while science is even dependent upon it for her means of progress." He said that it was the mission of the mechanical engineer to subjugate all natural forces and elements.

John E. Sweet read a paper entitled, A New Principle in Steam Piston Packing. A discussion followed, in which Professors Webb and Wood, of Stevens Institute; G. S. Strong, of New York; F. H. Ball, of Erie; Oberlin Smith, of Bridgeton; H. D. Parsons, of New York; A. Sinclair, of Chicago; O. C. Woolson, of Newark; Daniel Ashworth, of Pittsburgh, and F. R. Almond, of Brooklyn, participated.

On the second day, at the morning session, the report of the Council showed the number of members to be 813. Treasurer Wiley reported that the receipts during the past year amounted to $10,586, and the expenses to $10,413.

An election for officers to serve during the ensuing year resulted as follows: President, Horace See, Philadelphia; Vice-Presidents, W. S. G. Baker, Baltimore; Henry G. Morris, Philadelphia, and C. J. H. Woodbury, Boston; Treasurer, William H. Wiley, New York; Managers, Stephen W. Baldwin, New York; Frederic Grinnell, Providence, R. I., and Morris Sellers, Chicago.

The following papers were read: Experiments and Experiences with Blowers, and Economical Method of Heating and Ventilating an Office and Warehouse Buildings, by Henry I. Snell; Internal Friction of Non-Condensing Engines, by Professor R. H. Thurston, and Power-Press Problems, by Oberlin Smith.

In the afternoon the members visited the Baldwin Locomotive Works; Bement, Miles & Company's machine works; Bergner & Engel's brewery; William Cramp & Sons' ship-building works; Henry Disston & Sons' saw-works at Tacony, and other manufacturing establishments.

At the evening session the following papers were read: The Milling Machine as a Substitute for the Planer in Machine Construction, by John J. Grant. Frank Van Vleck being absent, his paper on Standard Section Lining was read by Professor R. H. Thurston, and a second paper on the same subject was read by Professor Hutton. Considerable discussion followed, during which Messrs. John J. Grant, Henry R. Towne, Orosco Woolson, T. Halsey, F. G. Coggin, and James B. Ladd participated. The next paper read, by Percy A. Sanguinetti, was

entitled Divergencies in Flange Diameters of Pumps, Valves, etc., of Different Makers. It was discussed by Henry R. Towne, W. Barnett Le Van, J. M. Witnan, A. H. Raynal, William Kent, William F. Mattes, and others. William O. Webber's paper, Centrifugal Pumps and their Efficiencies, was read by Professor Hutton, and was discussed by Professor Wood, Hugo Bilgram, and James E. Denton.

A committee, consisting of Percy A. Sanguinetti, E. F. C. Davis, William F. Mattes, S. S. Webber, and A. H. Raynal was appointed to consider the advisability of adopting standard sizes of flange diameters.

On the third day, November 30, the first paper presented, on Friction in Toothed Gearing, was read by Gaetano Lanza, of Boston.

The second paper read was by Jerome Soudericker, of Boston, on an Investigation as to How to Test the Strength of Cements.

Edgar C. Felton, of Steelton, Pa., next read a paper entitled, Notes on Results Obtained from Steel Tested Shortly after Rolling.

Lewis F. Lyne, of Jersey City, read a paper on the Use of Kerosene Oil in Steam Boilers.

A paper on the Improvement of Shaft Governors was read by Frank F. Ball. A paper on a Road-bed for Bridge Structures was read by O. C. Woodson. John Coffin read a paper on Steel Car Axles.

James M. Dodge, of Philadelphia, suggested a New Method of Stocking and Reloading Coal, in which he recommended the use of the flying extension. In this connection he said:

"The average cost of stocking coal on either side of a trestle to a distance of, say, 20 ft. is about 30 cents a ton, whereas the cost of stocking coal with the flying extension is but a fraction of this amount. There are four of these conveyors now in use at the wharves of the Philadelphia & Reading Railroad at Port Richmond, Philadelphia, and others in process of erection. By means of the flying extension and reloading conveyors it is possible to store immense quantities of coal on vacant land at some distance from the sea-coast and cheaply reload it and deliver it at tidewater as called for, instead of storing coal under expensive trestlework and upon valuable dock property."

In the evening there was a reception at the Academy of Fine Arts, given by citizens of Philadelphia.

The fourth day, December 1, was devoted to an excursion to Bethlehem, Pa. The members took a special train in the morning, and during the day visited Lehigh University, the Lehigh Zinc Works, and the Bethlehem Iron Company's mills. They returned to Philadelphia in the afternoon, and in the evening visited the Opera House, by special invitation.

The visit to Bethlehem concluded the meeting. It was decided to hold the spring meeting in Nashville, Tenn., but a resolution was afterward passed that the Society should meet in Cincinnati, O., and proceed to Nashville after one day's session in the other city.

Military Service Institute.

A REGULAR meeting was held on Governor's Island, N. Y., November 26. The paper for the meeting was by Captain Rogers Birnie, Jr., of the Ordnance Corps, and the subject was Gun-Making in the United States. The paper was exhaustive, and was prepared for publication rather than presentation to an audience. Consequently it was not read through, but summarized in places. It historically reviewed gun-making in this country, beginning with the Rodman and Dahlgren patents, which, some decades ago, gave this country a brief period of superiority in an industry in which she is now somewhat behind. He analyzed at length the cast-iron gun, showing its impracticability from every possible point of view, and said that it was practically abandoned in 1871. In view of the annual attempts to obtain appropriations for cast-iron guns, this analysis of them will be of public interest to all having sufficient technical information to grasp it.

He analyzed the various patents tested of late years, including the Lyman multicharge gun, the Woodbridge wire gun, the Norman-Wiard guns. He said that the only valuable results had been obtained from the conversion of the old smooth-bore Rodmans into 8-in. rifles, of which 210 had been completed and mounted. He further said that the lesson of the last 10 years in the Ordnance Department investigations showed clearly that success in gun-making would come from steady and persistent endeavors to perfect the best system, instead of endeavoring to find new systems. The multicharge gun was clearly inferior, under all possible circumstances, to the breech charged gun.

At great length, but at no greater length than the importance of the question, in view of the endeavors to get appropriations for cast-steel guns, he showed that the same fundamental objections which lie against cast-iron guns lie against those of cast-steel. The effect of cooling a cast-steel gun from the inside was nullified by the annealing of the gun afterward. He concluded that the only guns worth while to manufacture at the present time were built-up guns of forged steel. He also showed the meagerness of Congressional appropriations, stating that in 20 years only $1,500,000 had been expended for the obtaining of cannon, a sum no greater than was needed to complete a single steel cruiser without its armament.

AT a regular meeting held December 8, Lieutenant E. M. Weaver, Jr., read a paper on the Armament of the Outside Line, in which he referred to the exposed condition of the coast. He took up the recommendations of the Fortification Board, and argued that the kind of guns proposed along the coast would not ward off an enemy with a 10-mile range, but, on the contrary, would be an incentive to attack in order to turn the guns inland, against the property they were designed to protect. As no serious attack would be made by an enemy east of Penobscot Bay, efficient fortifications, with guns of at least 20-in. caliber, should begin at that point. Otherwise, and as proposed by the Fortification Board, a force landing at the bay could proceed, under cover of a fleet, as far as Portland, without much trouble. Thus adequate defenses along the Maine coast have more than a local bearing. There should be large guns also at Dover. Cape Ann offered few temptations to an invader, but Boston, although well entrenched by nature, needs larger guns than have been recommended. In regard to the next and most important point of defense, Narragansett Bay, the speaker had a good deal to say. It might be possible to protect the bay itself with the proposed 16-in. guns, but better arrangements would need to be made to save Newport from bombardment. With Newport destroyed and the passage clear into the Sound, the Connecticut towns and cities would at once become endangered, and a way would be opened toward New York. There ought, therefore, to be provisions at Narragansett Bay to repel invasion.

Points along Eastern Long Island and the Sound could then wait for fortifications until an emergency was actually threatened, but the protection for New York should at once begin on Hart's Island and at Hewlett's and Willet's Points on the Sound, and at Rockaway Inlet, East Bank, Sandy Hook, and Coney Island, with guns of at least 20-in. caliber at each point. Large guns might also be profitably put at Forts Lafayette and Wadsworth, but not at the expense of outside fortifications. New York could be safe only by keeping an enemy out of the Lower Bay. The property in danger at Portland, Boston, Newport and New York in case of war is estimated at $3,500,000,000. If one-tenth of 1 per cent. of that value were appropriated as an insurance of this property danger could be averted. The writer discussed the best way of making such guns. He concluded that the Government ought to supplement its own operations with private enterprise, and leave the decision upon results to the artillery instead of to theorists. The men best qualified to judge of guns were those who had to stand behind them. Gun-making had advanced in this country in spite of Government officials rather than through them, and hence private enterprise ought to be given a fair chance.

OBITUARY.

LOUIS A. BOSDEVEX, who died at his residence in Jersey City, N. J., December 3, had been for many years in the service of the Pennsylvania Railroad. For some years past he had been Master Mechanic in charge of the Meadows shops on the New York Division of that road.

ROBERT CURTIS, who died in Columbus, O., December 4, was born in Syracuse, N. Y., in 1835, and when still young entered the Erie Railroad shops in Buffalo. He afterward went to Milwaukee and was for several years on the Milwaukee & St. Paul road, and was then made Superintendent of the Bay State Iron Works in Milwaukee. In 1860 he was appointed General Foreman of the Columbus, Chicago & Indiana Central shops at Columbus, O., and soon after became Master Mechanic. He has since remained in the same position through all the changes in name and ownership of the road. He superintended the design and construction of the extensive shops lately completed at Columbus. Mr. Curtis stood very high in his profession, and in the Master Mechanics' Association his opinions and views on matters pertaining to mechanics were respected and known to be very valuable.

GENERAL ZENAS C. PRIEST, who died at Little Falls, N. Y., December 4, in the 82d year of his age, was almost if not quite the oldest railroad officer in this country, both in age and term of service. He was born in Herkimer County, N. Y., in 1806, and after working in turn as a blacksmith, a salesman, and cap-

tain of a packet boat on the Erie Canal, he entered the service of the old Utica & Schenectady Railroad in 1835, working first as a conductor and afterward as roadmaster. In 1840 he was made Superintendent of the Utica & Syracuse Railroad, and when the consolidation which formed the New York Central Company was completed, he remained with the new company as Division Superintendent. Notwithstanding his great age, General Priest continued actively at work until a few weeks before his death, giving up his duties only when his last illness disabled him. He was always considered an active and efficient officer. At the time of his death he had been 52 years in railroad work and 47 years a Superintendent. He was the only man who was in the employ of the Utica & Schenectady Company in 1836 who remained on the New York Central 50 years later.

Mr. JAMES McC. CREIGHTON, who died in Philadelphia, November 20, was born in Pittsburgh in 1833 and was educated in that city. During nearly all his active life he was engaged in various classes of transportation service. He became one of the assistants, at Pittsburgh, in 1852, of Leech & Co., who were then operating the portion of the Pennsylvania Canal east of the Allegheny Mountains. After holding positions in which he gained much experience in transportation affairs, he was, on January 1, 1865, appointed General Agent in charge of the Pennsylvania Railroad Company's interests at Pittsburgh. In 1874 he was appointed Superintendent of the West Pennsylvania Division. In 1879 he was appointed Manager of the Empire Line, and in 1880 General Freight Agent of the Pennsylvania Railroad. After holding this position for a few years he engaged in other business, and subsequently he was elected President of the Schuylkill River East Side Railroad. He resigned that office in 1885, to become President of the Ohio Valley Natural Gas Company, which position he held at the time of his death. Mr. Creighton was endowed with great capacity for the transaction of many of the intricate duties connected with the management of railroad affairs, and at various stages of his career rendered exceptionally important and useful service. A widow and three children survive him.

GENERAL WILLIAM HENSLEY EMORY, who died in Washington, December 1, was born at Poplar Grove, Md., and graduated from West Point in 1831, receiving a commission in the Second Artillery, but resigned two years later. After devoting himself to civil engineering the two ensuing years, he was reappointed First Lieutenant of Topographical Engineers. He was diligently engaged until the breaking out of the Mexican War in surveys on coast fortifications and in running the boundary between the United States and the British Provinces. He was Acting Assistant Adjutant-General of Kearny's expedition to California. He was brevetted Captain for his services on the Pacific Coast. He was promoted Lieutenant-Colonel for his services in running the boundary line between the United States and Mexico. His notes on the military reconnoissance of the Arkansas and Gila Rivers and New Mexico and California, ably written and highly interesting, show that he possessed no ordinary talent as a surveyor and scholar.

As a topographical engineer, Brigadier-General Emory had few equals. In 1855 he was appointed Major of the Second Cavalry and transferred to the First Cavalry, and until the breaking out of the Rebellion was employed in frontier duty. In 1861 he was appointed to a volunteer command, and served through the war as Brigadier and Major-General. He retired from active service in 1876, and has since lived in Washington.

JAMES CARSON BREVOORT died December 7 at his residence in Brooklyn, N. Y. Born in New York City in 1818, he graduated from the École Centrale des Arts et Manufactures, in Paris, as a civil engineer, and before returning to this country made a tour of the manufacturing districts of England and studied carefully that country's system of railroad construction. During 1838 he was engaged at the West Point foundry, and in 1841 assisted as surveyor on the North-western boundary survey. The year following he accompanied Washington Irving, United States Minister to Spain, as private secretary and attaché of legation. In 1845 he married a daughter of Judge Leffert Lefferts and settled in Brooklyn, where he has since resided. In 1847 he was a member of the Charter Commission, and later served on the Brooklyn Board of Education and as a member of the Constructing Board of Water Commissioners. He assisted in 1863 in the formation of the Long Island Historical Society, of which he was the first President, holding the office for 10 years. In the same year he was made a Regent of the University of New York and received the degree of Doctor of Laws from Williams College. Among the many literary and scientific societies of which he was a member were the American Association for the Advancement of Science, the New York Historical Society, the American Geographical Society, the Massachusetts and Pennsylvania Historical Societies, and the Academy of Natural Sciences.

Mr. Brevoort inherited from his father a library of 6,000 volumes, including many rare and valuable Americana, collected in Europe from 1810 to 1832. He added to the library, which at present contains some 10,000 volumes. He had also a very valuable collection of medals, coins, and manuscripts, from which some years ago he began to make systematic distributions among institutions of learning.

PERSONALS.

Mr. F. N. FINNEY has resigned his position as Managing Director of the Wisconsin Central Railroad, after long service with the company.

Mr. WALTER G. BERG, formerly Assistant Engineer, is now Principal Assistant Engineer of the Lehigh Valley Railroad, and will have special charge of work at the eastern terminus.

Mr. W. R. COATS, of Kalamazoo, Mich., has charge of surveys and estimates for water-works at Hillsboro, Ill.

Mr. F. W. PRATT is now Chief Engineer of the Wisconsin Central Railroad and its associated lines.

Mr. T. G. BAYLOR, Civil Engineer, late of Atlanta, Ga., has removed to Charleston, W. Va., where he will remain for the present.

Mr. ALFRED D. OTTEWELL is Engineer of the California Bridge Company, and has his office in San Francisco.

Mr. R. J. DUNCAN, late on the Missouri Pacific, has been appointed General Superintendent of the Fort Worth & Denver City Railroad.

Mr. R. ANGST is Chief Engineer of the Duluth & Iron Range Railroad, with office at Two Harbors, Minn.

The partnership lately existing between GEORGE R. WAITE, MARTIN VAN HARLINGEN, and HENRY MACTIER, under the firm name of Waite, Van Harlingen & Mactier, was dissolved on the nineteenth day of November, 1887, by mutual consent. Two of the old firm have formed a co-partnership, under the firm name of Waite & Van Harlingen, for the purpose of carrying on business as engineers and contractors at 308 Walnut Street, Philadelphia.

Mr. F. P. DIMPFEL, well known as the inventor of the Dimpfel boiler, which caused much controversy in the mechanical world, is now employed in introducing a preserver and germinator for cereals and seeds of all kinds.

Mr. SAMUEL SPENCER, who succeeds Robert Garrett as President of the Baltimore & Ohio Railroad Company, has been in the service of that company for nearly 20 years, and Vice-President for four years past. He is thoroughly familiar with the company's system, and is credited with more progressive ideas than some of his predecessors.

Mr. GEORGE R. HARDY has resigned his position as Chief Engineer of the Lake Shore & Michigan Southern road. He went to that road from the Boston & Albany a year ago.

Mr. W. M. S. DUNN, formerly General Superintendent of the Chesapeake & Ohio road, has returned to that road as Consulting Engineer.

Mr. THOMAS M. KING has resigned his position as Second Vice-President of the Baltimore & Ohio Railroad Company.

Mr. BURR BASSELL, of Los Angeles, Cal., has been appointed Chief Engineer of the Semi-Tropic Land & Water Company.

NOTES AND NEWS.

Blast Furnaces of the United States.—The condition of the blast furnaces, and their weekly productive capacity in tons, on December 1, as given by the *Iron Age*, was as follows :

	In Blast.		Out of Blast.	
Fuel.	No.	Capacity.	No.	Capacity.
Charcoal	70	11,718	105	8,908
Anthracite	122	39,437	76	18,054
Bituminous and coke	144	88,835	65	22,997
Total	336	139,990	246	49,959

The *Iron Age* says : "As will be observed from the figures given, there has been a decline in the capacity of the furnaces running on anthracite and coke pig. As yet, this falling off is

small, but since then additional furnaces have gone out of blast. Still, the make continues heavy, at the rate of 128,322 gross tons per week, not counting in the charcoal furnaces, which add 11,718 tons weekly, making the total 140,040 tons. The tendency, however, is now evidently in the direction of a slightly reduced make."

Baltimore & Ohio Employés' Relief Association.—The September sheet of this Association shows the payment of benefits to members as follows :

	Number.	Amount.
Accidental deaths	7	$10,000
Accidental injuries	276	4,028
Natural deaths	9	4,000
Natural injuries	598	8,401
Physicians' bills	180	1,321
Total	1,070	$27,750

From the organization of the Association up to September 30 there had been made by the Association total payments of $1,510,051 in benefits.

The Brussels International Exhibition.—The International Exhibition at Brussels, Belgium, for which the arrangements are substantially completed, will open on the first Saturday in May, 1888, and will remain open until November 3. Applications for space must be filed before January 15, 1888, and entries made before April 15 ; exhibits must be in place by April 25.

Messrs. Armstrong, Knauer & Co. have been appointed authorized agents of the Executive Committee for the United States. Applications will be received by them and information given on application to their office at No. 824 Broadway, New York City.

The Dubuque Bridge.—The new highway bridge just completed at Dubuque, Ia., is the only bridge over the Mississippi except the St. Louis Bridge, built without a draw. The new bridge is 70 ft. above the ordinary stage of water in the channel and 50 ft. above high water. It rests on seven piers, substructures of masonry founded on piles, having an iron superstructure with an 18-ft. roadway, on each side of which is a 5-ft. walk. There are four spans, each 205 ft. long, two of 248 ft. and one of 363 ft. On the east side of the river two spans, each 120 ft. long, form a viaduct over the tracks of the Illinois Central and the Chicago, Burlington & Northern railroads, which had to be crossed in making the approach to the bridge. The 363-ft. span extends over the channel of the river, and is a cantilever span, with its center 5 ft. higher than the ends. The entire length of the bridge is 2,800 ft. Of this length the main bridge comprises 1,760 ft., and the approach on the east side 1,040 ft. The location of this bridge is just 75 ft. south of the railroad bridge, the draw of which swings under the cantilever span of the highway bridge.

The contractors for the entire structure were H. E. Horton & Co., and the contract price was $125,000.

Tin Production of the World.—The production and consumption of tin for 10 years past are estimated as follows, in tons :

	Production.	Consumption.
1877	34,367	32,371
1878	35,849	34,918
1879	38,882	37,839
1880	38,321	39,533
1881	39,388	43,483
1882	39,771	42,045
1883	45,375	45,686
1884	43,851	45,735
1885	42,976	43,039
1886	44,687	46,520

Experts think that no considerable increase of production can be expected from the present sources of supply. It will be seen that the consumption now exceeds the production.

Utilization of Waste Products.—In a lecture recently delivered before the Philosophical Society of Sheffield, England, Mr. A. H. Allen said that it was not so long ago that blast-furnace gases were allowed to burn freely at the mouths of the furnaces, and the utilization of them for heating the boilers and blast is a distinct step in advance. With furnaces consuming coke this is all that can be done, but the successful utilization of the tar and ammonia condensable from furnaces consuming bituminous coal is a further step of great practical importance. We must not forget the enormous quantities of slag which form another secondary product of the reaction in the blast-furnace. It is calculated by good authorities that 1¼ tons of blast-furnace slag is produced for every ton of pig-iron obtained, which in England would mean an average yearly production of 8,000,000 tons of slag. The enormous quantity of this material produced has doubtless stood in the way of its utilization, and where there is a constant demand for it for road-making purposes at a fairly remunerative rate there is not much encouragement to go farther with it. At Middlesborough, however, it has been found of great service in the construction of the breakwater at the mouth of the Tees, for which purpose about 500,000 tons of slag are used annually. Again, slag-wool is now being manufactured at the rate of 15 to 20 tons per week. It is used as a non-conducting material for covering boilers, and so forth, and to put under flooring to deaden the sound. At the works of the Britain Glass Company, in Northamptonshire, blast-furnace slag is run in a molten state into a glass-furnace, heated by Siemens gas, and is then mixed with about its own weight of sand and alkali, and made into glass. The slag which results from the basic process contains a considerable quantity of phosphate of lime, and a number of ingenious processes have been devised for recovering this in a comparatively pure state. At the Northeastern Company's Works, Middlesborough, they are making from 800 to 1,000 tons per week of the slag, and have just erected a large mill for grinding this into powder. They have already shipped upward of 60,000 tons of the raw slag to Germany.

A Locomotive with "Polygonal" Drivers.—The Hinkley Locomotive Company in Boston has just completed a locomotive of the ordinary eight-wheel pattern, but with one pair of driving-wheels only, the place of the usual second pair being taken by a pair of trailing-wheels. The engine has 18 x 24 in. cylinders and the drivers are 67 in. diameter.

The Swinerton locomotive driving-wheel is the peculiar feature of this engine. It differs from the ordinary driving-wheel in that it has a series of plane facets of any length from 1 to 2 in. around its periphery or tread, and these facets are continuous and connected with each other by very obtuse angles. The inventor claims that by this arrangement the adhesion is greatly increased.

The engine is owned by the Swinerton Locomotive Driving-Wheel Company, and is to be tried for a time on the Boston & Lowell road.

Irrigation in Southern California.—The Semi-Tropic Land & Water Company, in Southern California, is expending some $300,000 on the survey and sub-division of a tract of 32,000 acres of land, and on the development, storage, and distribution of water for both town and irrigation purposes.

The Sierra Madre range of mountains furnishes the major portion of the water owned and controlled by this company ; artesian wells will supply a portion of the lands.

The general plan for the development of water is to drive tunnels near the base of the mountain at the most favorable points presented by the small side cañons leading into the main cañon. The geological formation is most favorable on the north-west side of the main cañon. The rock is principally gray granite, presenting many fissures well suited to the storing up and gradual conveyance away of the rain-fall and the melted snows from higher altitudes.

Several tunnels are being made which have yielded surprisingly large volumes of water. In one instance a tunnel was started in solid granite bed-rock, where a superficial view of the situation would promise only discouragement and ultimate failure, and after going in about 150 ft. from the portal, the granite rim was broken through, and a stratum of sand and bowlders saturated with water was encountered, which yielded a large stream.

The water from the tunnels and side cañons will be conveyed in small pipes as laterals to a larger one, which latter will discharge near the mouth of the main cañon into a large box-flume. There is 700 ft. of this flume, made of 2-in. rough redwood, and imbedded in the side of the cañon, which conveys the water of the stream out of its natural channel to a point from which an open cement ditch about 10 miles in length will conduct the water to the distributing reservoir.

At the head of the flume, near the mouth of the cañon, and in the channel of the stream, two cribs will be anchored to bed-rock in such a manner as to present little or no obstruction to flood-water and drift material during the rainy season. A safer and better plan, but more expensive, would be to convey the water out of its channel by means of a tunnel.

The open ditch (now about half completed) is rock-walled and cemented its entire length, and is estimated to carry about 5,000 "miners' inches" of water, or 100 cubic ft., per second.

In addition to the distributing reservoir there will be a storage and service reservoir for town use, thus providing two separate and independent systems of water distribution—one for irrigation, the other for domestic use.

It is proposed to use partly cement concrete pipe (where there will be no water pressure or head) and partly sheet-iron pipe for the irrigation system. Strong cast-iron pipe, ample for fire pressure, is to be used for the domestic supply.

	Range.	Weight per Cu. Ft.	Specific Gravity.	Resistance to Indentation.	Elasticity.	Transverse Strength.
WHITE OAK. *Quercus alba, L.*	East of the Rocky Mountains.	46.35	0.7470 (4)	3388 (6)	97089 (2)	905 (4)
CHESTNUT OR ROCK-CHESTNUT OAK. *Quercus prinus, L.*	Northeastern and in Kentucky, Tennessee, and Alabama.	46.73	0.7499 (3)	3688 (5)	125473 (1)	1031 (2)
BASKET OR COW OAK. *Quercus Michauxii, Nutt.*	Southeastern.	50.10	0.8039 (2)	3725 (4)	96373 (3)	1118 (1)
BURR, MOSSY-CUP, OR OVER-CUP OAK. *Quercus macrocarpa, Michx.*	Northern U. S.	46.45	0.7453 (6)	3730 (3)	92929 (4)	982 (3)
POST OR IRON OAK. *Quercus obtusiloba, Michx.*	East of Rocky Mountains.	52.14	0.8367 (1)	4415 (1)	83257 (5)	872 (6)
CALIFORNIA WHITE OAK. *Quercus Garryana, Dougl.*	Pacific Coast.	46.45	0.7453 (5)	3846 (2)	81109 (6)	879 (5)

Naval Notes.—The Navy Department has asked for proposals for a submarine torpedo boat. Bids will be received until March 12 next. The proposals must be accompanied by drawings and description of the boat which the bidder proposes to build. Information as to the general requirements to be fulfilled can be obtained at the Navy Department.

The work now in progress at the naval gun shop in the Washington Navy Yard employs nearly 400 men. There are now under construction four 10-in. steel breech-loading rifled guns for the monitor *Miantonomoh*, and ten 6-in. steel breech-loading rifled guns for general service. There is also a large amount of work going on in the fitting up of tubes, hoops, etc., for other guns. In addition to the gun work there are in progress four turret mounts for the *Miantonomoh's* 10-in. guns, and four central-pivot carriages for 6-in. guns. In the foundry there are 1,000 cast-iron shells for 6-in. guns. Work on the secondary battery for the *Chicago* has been discontinued for the present, and will not be resumed until a further appropriation is made.

A recent test made at Newport between a steam launch of the old naval pattern and one of the new launches of the Herreshoff make resulted in a very decided victory for the latter. The two were connected by a heavy hawser, stern to stern, and started in opposite directions. The Herreshoff boat, however, managed to make considerable headway, dragging the other boat after her.

Car Heating.—The Connecticut River Railroad Company, which uses the Emerson system of steam heating, has provided a new system for heating the cars at the terminus at Springfield, Mass. It consists of a series of underground steam-pipes from the boiler-house, running to partially buried boxes, where heavy rubber hose can be connected with the steam-pipes of a car. The side tracks where the cars are cleaned after a trip and are dusted for the start are opposite the boiler-house, so that the system could be easily tried, but the pipes could be carried a greater distance with but little more pains. All that has to be done when it is desirable to heat a car or a string of cars is to lift the cover from one of the traps and connect it with the steam-piping under the car. The whole string of say a dozen or 15 cars can be heated as well as one. The connection can be made at the ends of any of the intervening cars. Any car can be shut off. There are about a dozen of the traps scattered up and down the yard so that it is an easy matter to make connections with the steam.

The joint committee of the several railroad clubs appointed to consider the question of couplings for steam-heating pipes has held two meetings, but has taken no decided action.

The Central Railroad Company of New Jersey has had one train on the Newark & Elizabeth Branch equipped with the Gold system of steam-heating for some time, and has recently ordered all the trains on that branch to be equipped in the same manner. It is expected that, if the results this winter are satisfactory, all the passenger trains on the road will be supplied with steam heat next winter.

Oak for Railroad Ties.—The Forestry Division of the United States Department of Agriculture has issued the following:

"In the use of oak for cross-ties, the specifications of most roads, especially those of the South, call for White Oak (*Quercus alba*), a timber which is sought for also by almost every industry employing oak, and which is therefore rapidly decreasing and approaching comparative exhaustion. Meanwhile, millions of feet of Tan-bark or Chestnut Oak (*Quercus prinus*) are rotting in the forests, after being stripped of their bark, because their value for cross-ties is not known or is underestimated in many regions.

"This lack of appreciation of the value of this wood causes not only waste of the wood itself, but waste of the bark also, as without ready demand for the wood, it does not pay to peel the larger limbs.

"From information furnished by Dr. Mohr, of Mobile, Ala., an expert in forestry statistics and agent of this department, it appears that from the line of the Louisville & Nashville Railroad, south of the Tennessee River, between 5,000 and 7,000 cords of bark are shipped annually, involving the felling in that district alone of from 10,000 to 13,000 trees which are consigned to useless destruction, while capable of yielding not less than 100,000 first-class railroad ties.

"As to the lasting quality of the timber of Chestnut Oak experiences are reported from Cullman, Ala., to the effect that posts of this oak outlast those made of White Oak, partly probably because the timber is peeled. One reliable report states that Tan-Bark Oak posts were found to be sound after 12 years, while those of White Oak in the same construction had to be replaced several years sooner. Reports from railroad companies, where this wood is used for ties, give their life as from 5 to 10 years, while the reports for White Oak give from 3 to 12 years. In the average, all the oaks which are known as white oaks, last between 7 and 8 years in the road-bed.

"That the oaks of this class may be used for railroad construction interchangeably, and do not offer any appreciable differences in the qualities most essential for a good railroad tie, the following table, compiled from the *Census Report*, may serve to show. The column of specific gravity will allow an estimate in regard to adhesion of spikes, while the column of indentation allows an estimate as to resistance to cutting of rail. The position as to quality, in comparison with the other kinds mentioned, is indicated by numbers in parenthesis.

"From these figures it would seem that, contrary to the accepted notion, the White Oak, *par excellence*, is inferior in all particulars to the Chestnut Oak, and in general not superior to any of the others."

Prizes for Small Motors for Electric Lighting.—The prizes offered by the English Society of Arts for small power motors applicable to electric lighting are to be awarded on the results of a trial which is to take place in May or June of this year, if a sufficient number of competitors present themselves. The motors which may be entered for the prizes are portable, semi-portable, and detached steam-engines, either condensing or non-condensing gas-engines working with lighting gas, water gas, or producer gas; hydro-carbon engines, using either liquid or vapor hydro-carbon; water motors; compressed-air and exhaustion motors. The maximum power at which they may be tested is 20 H.P., and no competition will be held unless 10 motors, at least, are entered. The points of merit considered of the greatest importance will be: *a.* Regularity of speed under varying loads. *b.* Regularity of speed during the various parts of one revolution, or one cycle of revolutions. *c.* Power of automatically varying speed to suit arc lights. *d.* Noiselessness. *e.* First cost. *f.* Cost of running. *g.* Cost of maintenance. Further information can be obtained from Mr. H. Trueman Wood, Secretary of the Society of Arts, Adelphi, London, England.